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"He that goes about to forward agricultural improvement must begin by finding out the true reason of what is called routine, or 'the custom of the country.' It sometimes happens that these reasons are only accidental, and then you may dismiss them fearlessly; but often it turns out that every-day practice rests on a solid foundation of facts; and then if you make an onslaught on local prejudices, they will be sure to beat you."

"The true course for the agricultural improver is, to take one step at a time, to gain a clear insight into facts by experience, not to try to go too fast, and to trust to the work of time."

"If practice which sets up to do without theory is contemptible, theory without practice is foolhardy and perfectly useless."—*From the Rural Economy of England, Scotland and Ireland,* by LEONCE DE LAVERGNE.

Journal communications should be addressed to the Editor,
3, Pierrepont Street, Bath.

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JOURNAL

OF THE

BATH AND WEST AND SOUTHERN COUNTIES SOCIETY.

Original Articles and Reports.

I.—ABOUT THOSE WHO LIVE FROM THE LAND.

By the Right Hon. the Earl Selborne, K.G., G.C.M.G.

Within the last few months I have read in one paper or another statements to the effect that the south country agricultural labourer is a cringing and oppressed serf, that the farmers are unscrupulous profiteers, and that the landowners are nothing but a fifth wheel in the agricultural coach. Those who say or write such things either deliberately say or write what they know to be untrue or they are hopelessly ignorant of the facts and conditions of country life. The ignorance of many of our urban dwellers is so profound on the subject and yet they are so free in their expressions of opinion, that I believe the latter to be the more probable explanation. We, who live in the country, are equally ignorant of much which goes on in the industrial centres, let us say of the conditions of the cotton industry, but we do not write on the subject or pass judgments on those unknown to us.

The south-country agricultural labourer is psychologically quite different to his north-country brother and any argument from the one to the other is futile. Those who have been born and brought up with the former and really know him have a great respect and affection for him. He is not in the least servile; he knows his rights perfectly well and is very tenacious of them and of his customs. If anyone scouts his customs or infringes his rights, he will not work for him nor respond to any advances. His manners are naturally good and he is of a very kindly disposition. He is a slow but sure thinker. His preference is to die in the cottage into which he

married, but that reluctance to move will not make him stay with a bad employer. He devotes quite an important part of his garden to flowers, and, while his wages were still quite low, he decided that his women folk should stay at home and not work in the fields. He works shorter hours, and in a more leisurely fashion during those hours, than his northern brother, and there will always be the same difference between the two because it is based on temperament. It has happened half a dozen times within my own experience that a man of my parish has come back from the North of England, or from Canada, or from the U.S.A., where he was getting big wages, and has settled down for life to the old conditions, his explanation of this being given in the pregnant phrase—" I won't be druv."

A preponderating majority of the men in the Navy before the war came from south of a line drawn from Bristol to Hull and probably also a majority of those in the Army. When war broke out there were fourteen men already in the Army from four cottages alone on my small estate, and every family in the parish had a representative already in the Navy or the Army. And a great number of these men come back to their own parish after they have served their time and settle down for life. I do not know whether that is so elsewhere, but it is true of Hampshire.

Therefore when war broke out there were much fewer men of military age available in the southern than there were in the northern counties, but they went at once just like the men of the North, and nothing was finer or more characteristic than the attitude of the old soldiers. There was no talk about it. They threw up their jobs and rejoined immediately, as if there was no possibility of doubt about their duty, and this was long before the new and liberal scale of separation allowances had been provided by Parliament. It was with great difficulty that some of the men of military age could be persuaded that it was their duty to stay on the land and grow food, but fortunately that has at last been made clear by the voice of authority to the precious few who remain. Wages have risen, but times have been bad for many of them. Nevertheless, they have stuck to their work, stolidly ploughing against the Kaiser. Except in a few instances, there has been no strike or talk of strikes, and they have resisted to a wonderful degree the temptation of " munitions " wages, not from poverty of spirit or lack of enterprise but because they know in their bones that the place where they can best serve England is on the land.

Wages were too low before the war, that is comparing the south-country agricultural labourer not with the town labourer, than whom

he was better off, but as a skilled workman with other skilled workmen. To understand how it was that he was underpaid, it is necessary to understand the history of agriculture in England between the end of the 'seventies and the beginning of the new century. In that period, when other wages were going up, those of the agricultural labourer actually went down, but had recovered themselves and were steadily rising before the war. That was the period when much of agriculture was fighting for its life in an acute economic depression, when great numbers of farmers and landowners were utterly ruined, when millions of acres of arable land went down to grass, and when the number of men employed on the land was sadly diminished. The tide had turned by 1906, and for the years immediately preceding the war a competent farmer ought to have been doing reasonably well in his business. The wages of the agricultural labourer rose steadily at the same time, but not as fast as they ought to have done.

Has the farmer been a profiteer during the war? I do not think a more cruelly or cynically unjust suggestion could be made. The farmer has had far better prices for his produce during the war than ever before in his life, but he has not been able to take full advantage of those prices because of the extraordinary difficulties which have confronted him in carrying on his business at all during the war, and because of the corresponding rise in price of all the articles he requires to buy for carrying on his business. But how were these war prices fixed? Did the farmer fix them? Not he. They were world prices. All through the years of agricultural depression, when farmers were being ruined by the thousand, certain kinds of foodstuffs were being imported into and sold in England at a lower price than that at which they could possibly be produced in England, and the urban consumer got the benefit. They were world prices. The farmer was told that they were the result of an excellent economic principle. The townsman may have pitied him, but he did not stir a finger to help him. But, directly the same "excellent economic principle" resulted in a great rise in the price of foodstuffs, the same urban consumer began to shout "profiteer." Was this generous? was it just? was it true? The Food Controller has now intervened and fixed the prices which the British farmer is to receive. He cannot fix the prices for the American farmer. Does the British farmer complain? of the way which Government departments have of doing business, Yes. Of the principle of fixing food prices, No; because he is a true patriot and he knows that it is a necessary expedient in war time. But he contrasts his attitude and that of the urban consumer

in the two periods to which I have referred, and he is not ashamed of the part which he has played.

How "messed about" the farmer has been during this war time no one who is not a farmer can understand. If he had had to deal with the Board of Agriculture alone, he would have grumbled and criticised and smiled; but, most unfortunately as I think, the Board of Agriculture has not been made exclusively responsible to Parliament for dealings with the farmer. In the matter of food production the War Office and the Food Controller, as well as the Board of Agriculture, have intimately interfered with the farmer's business, and it is quite wonderful how the farmer has managed to carry on under the circumstances. He is a difficult man to help, because he will put all official communications into the waste-paper basket without reading them, but in my judgment he has been very patient and efficient under it all and he has risen to the crisis from sheer sense of patriotism. The fact that but few farmers have left their farms and joined the Army is an excellent testimony to the sound sense of the class. The few that have done so had better hearts than heads, for quite certainly the war post of a farmer is on his farm.

Very difficult conditions will confront the farmers when the war is over as they will all the rest of us. They will have to pay much higher wages to their men, and the demobilised sailors and soldiers will need very tactful and sympathetic handling. No blame is imputed to those men by this statement; it is only according to human nature that this should be so. But what I should wish respectfully to impress upon the farmers, if I may, is that they must not only be prepared to pay high wages but also to study the conditions of their work and patiently to teach the men to earn those wages. I am quite sure that we ought to arrange for a full half holiday for them once a week, to be given preferably on the same day of the week as is devoted to a half holiday in the next adjacent village or country town. Of course there is a real difficulty in arranging for this and adjusting the work where there is a dairy herd, but the difficulty cannot be insuperable, because it is only half the difficulty which in the same case confronts us every Sunday.

The agricultural landowner has been accused by his urban critics of every social crime but one. No one has yet suggested that he is a war profiteer. It is not possible to prove a negative, but, bearing that limitation in mind, I will assert boldly as a fact that there has been no raising of rents during the war. On the contrary in vast numbers of cases, when the agricultural labourer joined the Army,

the landowner gave the cottage rent free to the wife, and, of course, he did not withdraw the gift when the liberal scale of separation allowance was granted. By all the laws of political economy he might have raised his farm rents, because his tenants were making better profits and because tithe had gone up. But no, he felt that the farmer should have all the encouragement possible to produce all the food he could for the country, and because it went against his instincts to make anything out of the war. His taxation has gone up by leaps and bounds. He has cheerfully parted with all his sport and little comforts; his much loved garden has become a wilderness of weeds and brambles. He is pinched by the war more than any class except others with small fixed incomes or those whose wages have not risen. But he is perfectly happy because he has never had a shadow of doubt about his duty. There is an impression in "urban circles" that all agricultural landowners are rich men. This is quite absurdly wrong. Of course it is well known that there are rich landowners in every county and what I have written applies to them only in a proportionate degree. But most squires are men of very moderate fortune, and what I have written is an exact description of their experience. But all alike, rich or poor, if they were of military age and sound in limb, as a matter of course joined up, when war was declared with Germany, as did their sons. They have given their all for England in this war and they have taken nothing.

But the accusation is that in normal times they are a fifth wheel in the agricultural coach and should be dispensed with. I will say nothing about their unpaid service of general utility in public business in their parish, rural district, petty sessional division, and county. Still less will I speak of the fact that it is to them that their neighbours of every class, and most particularly the agricultural labourers, come for help and advice in every conceivable variety of private affairs, because I should despair of conveying to their urban critics a glimmering of the truth, so utterly removed is it from their preconceptions. I will deal only with their economic place in agriculture.

If I were to say that in a very great number of cases they get no rent for their land, I should be stigmatised as wilfully mendacious by the urban critic; and yet that statement is literally true. What the landowner receives from the tenant farmer for the use of his land is always called "rent," but in a very great number of cases it really is nothing of the sort. It is interest (and one which the manufacturer would term uncommercial), on the industrial equipment of the land which makes the farmer's cultivation possible.

On a mixed farm of 500 acres a farmer should invest for the purposes of husbandry £5,000. But the landowner will have invested more than that sum in equipping the farm with its farm house and farm buildings, with its cottages, with its drains, fences, roads and water supply. If the rent of the farm is £500, and if 5 per cent. is reckoned as the rate of interest on the capital expended on its industrial equipment, after the landowner has paid his bills for the annual repairs and the other unavoidable charges, how much is left for the rent of the land? To avoid misunderstanding let me say that when I speak of "charges" in this connection, of course I do not mean to include mortgages, or jointures, or settlements, or anything of that sort, but only charges associated with the proper business management of an estate.

But the capital thus invested in the industrial equipment of an agricultural estate has to be constantly renewed. At the end of this war, for instance, every landowner will be confronted with an accumulation of arrears of work for which the labour has not been available, altogether apart from expenditure which will become requisite as the result of the conversion of grass land to arable. It is quite certain that the majority of the tenant farmers could not find the capital for this industrial equipment. The present system of industrial partnership between the landowner and the tenant farmer could be exchanged either for one where the farmer was always the owner, as has been done in Ireland, or for one where the State has nationalised the land, as Socialists demand. In the former case the yeoman farmer, and in the latter case the general taxpayer, would have to find the capital, which is now supplied by the landowner. It is not my purpose on this occasion to discuss the merits of either of these alternatives, but to point out that in the meantime the landowner is just as essential to the prosperity of agriculture as the farmer and that he is no more a fifth wheel to the agricultural coach than is the agricultural labourer.

The interests of agricultural labourers, tenant farmers, and agricultural landowners are by no means always identical. It is, therefore, reasonable that for the protection and promotion of their separate interests they should have distinct organisations whose business it is to look after them. But it is also true that all alike are equally and identically interested in the prosperity of agriculture and are desirous that the great national industry by which they live should receive fair treatment from Parliament. The industrial community, the urban consumers, and the importers of foodstuffs have all perfected organisations for the protection of their special interests. Is it not time that we also did the same?

II.—THE CORN PRODUCTION ACT.

By the Right Hon. F. D. Acland, M.P.

When I was paid the honour of being asked to continue an hereditary interest in the *Journal* by contributing an article to it, I felt bound to consent, for the *Journal* has for many years past been of great interest and value to me, and I felt it a duty to try in some manner to repay the debt I owe to it. It was not so easy to decide what to write about, but I have thought that it might be interesting to West Country agriculturists to set down as clearly as possible the exact provisions of the Corn Production Act, and some record of the influences and currents of opinion which led to its fashioning. The Corn Production Act vitally concerns the politics of agriculture, and though it is now fashionable to sneer at politics, it will be the duty of those connected in any way with land, thoroughly to understand the politics of agriculture in the future. Agriculture, as we all say, has been neglected by the State in the past, and though this is not wholly true (for no industry has had anything like the same amount of national money spent on its development) it is true in the sense that in the past we have never considered that the yield of food from British land was a vital question of our national existence, and we have, therefore, left agriculture alone so far as State regulation was concerned, whether in prosperity or adversity. These times are at an end. The State has decided that for the next six years agriculture shall be assisted in a particular manner. But with assistance comes control, and once control begins it does not often or easily stop. And if we are to take, as all of us ought, a useful part in so shaping the relations of the general body of citizens to our particular industry that agriculture shall flourish and contribute its utmost to national welfare we must read, mark, learn, and inwardly digest the working of those factors and influences whose action and re-action result in legislation and regulation. The influence of agriculturists in the future will, to a considerable extent, depend upon the degree to which they can understand what the great mass of their fellow citizens are needing from them and feeling about them. It is from this point of view that it may be worth while to record the main outlines of the chapter of agricultural history which closed when the Corn Production Bill received the Royal Assent. It may also be useful to consider how agriculture is likely to be affected by the administration of the Act. In attempting this task I shall not be able to avoid touching upon controversial points, but if in so doing I can avoid the controversial spirit I ought

also to avoid giving offence. I will go through the Act, section by section, first giving the effect and then commenting.

The first part of the Act fixes minimum prices per quarter (of 480 and 312lbs. respectively) for wheat or oats which are the crops of the six years 1917 to 1922 inclusive. The years are in three groups, the first, the next two, and the last three; and the prices are for wheat for the three periods:—60s., 55s., and 45s., and for oats:— 38s. 6d., 32s., and 24s. These prices are not to be paid by the State for each quarter produced. The basis of payment is each acre upon which wheat or oats have been grown, provided that the cultivation has not been negligent, and the payment which becomes due is four times the difference between the fixed price and the average price in respect of each acre grown with wheat, and five times the difference in respect of each acre grown with oats. The average price is the average of the weekly "Gazette" prices of home grown grain for the seven months, September to March, inclusive. From these data anyone can easily calculate what he will receive on account of the crops of any particular year as soon as, at the end of March of the year following, this "average price" is published. For instance, suppose a farmer has in 1919 ten acres under wheat and fifteen under oats. If in March, 1920, the average price of wheat for the preceding seven months is found to be 50s. and of oats 30s. he will receive on account of his crop four times the difference between 50s. and 55s. for his ten acres of wheat=£10, and five times the difference between 30s. and 32s. for his fifteen acres of oats=£7 10s. 0d. Total £17 10s. 0d. If, again, in March, 1923, the average price is declared to be 46s. for wheat and 18s. 6d. for oats the farmer would get nothing on his wheat, for the price is 1s. above the minimum price fixed for the year 1922, but he would get five times the difference between 18s. 6d. and 24s. on his fifteen acres of oats=£20 12s. 6d.

Though what has just been described is very straightforward and simple, the position that had to be met by the enactment of guaranteed prices was rather complicated, and so was the history through which this part of the Act passed before reaching its final form.

If any of us had been asked what the general agricultural situation demanded in the matter of legislation this Spring he would, I think, probably have replied to this effect:—"We need some sort of general guarantee that the price of cereals, and particularly of wheat, will not again be allowed to fall to the level of a quarter of a century ago; we need an incentive to plough up as much grass land as is reasonably likely to give a greater food supply as arable than under

grass; we need an inducement to treat our arable land as well as we possibly can in the way of fertilisers so that the greatest food-yield may be obtained from it." And if he could have established legislation autocratically, without regard to any of the limitations or difficulties of the present time, he would have given a fairly low permanent guarantee to meet the first point, a bonus per acre ploughed up to the satisfaction of some competent agricultural authority to meet the second, and would have offered farmers the chance of contracting to deliver their corn to the nation at a fixed price from year to year during the war period so as to meet their very natural anxiety lest having bought their fertilisers at war prices they might have to sell the crop they produced at peace prices. But under conditions as they were the Government had to find some simpler solution than this. They could not ask Parliament during the war to determine the permanent conditions of agriculture, they could not expect farmers to be satisfied either with bonuses which might be awarded by some rather distant War Agricultural Committee, or with contract prices that might be fixed by some still more distant Food Controller. On the whole it is probable that the solution ultimately found was as good a way of meeting the diverse needs of agricultulists as was possible under the difficult circumstances. The guarantee is not permanent, but it reaches well beyond the end of any imaginable war period; the fact that it is based on the acre ploughed, not on the yield, gives some fair encouragement to plough even if results are doubtful; and the gradually descending scale secures in some measure that even during a period of falling prices it shall pay to do one's cereal crops as well as possible.

There were two chief centres of discussion during the passing of this part of the Bill. One concerned the proposal of the Bill to give the benefit of the guaranteed minimum prices to all persons whether they had increased their corn production or not, and the other concerned the basis of payment, acreage or quarterage. On the first point the main argument against the Bill was that it would be impossible to expect persons who were not agriculturists to treat the Act as non-controversial unless its provisions took in some way the shape of a bargain between the agricultural community and the general body of taxpayers,—who would have to pay very large sums of money to farmers if grain prices returned after the war to anything like a pre-war level. An atmosphere of controversy and uncertainty is bad for any industry, but specially bad for agriculture, as plans have to be made for long periods in advance of their execution, so it was clearly wise to avoid, if possible,

anything of this sort. It was suggested that the element of a bargain or agreed settlement could be introduced in one of two ways:— either the Government could lay down and steadily carry out some permanent policy of increasing our food-yield for some years ahead, in which case the community would get an adequate return in extra security for their liability to pay; or (if the Bill were to be regarded purely as a war measure and plans of this kind could not be worked out during the war), the guaranteed minimum prices might only be made payable to a man who had reached or maintained some definite standard of cereal production. It was admitted that a workable definition of what a farmer should be expected to do before he could claim to share in the guaranteed prices was difficult to find, but that which had been suggested by the Milner Committee was put forward as most suitable. Their suggestion, as proposed for insertion in the Bill, was that the occupier should only be entitled to payment if either (*a*) he had increased the area of his holding under arable cultivation by at least one-fifth over the similar area in October, 1913, or (*b*) at least one-fifth of the total acreage under grass and annual crops should be devoted to wheat or oats in the year on account of which the claim was made. This is meant to provide for two different cases, both deserving of help, first, that of the man who had made a fair increase of his arable area to help the nation's need, secondly, that of the man who though not able to do much in the way of increase had maintained on his holding a good breadth of the essential grain crops. But the Government could not accept this, or any other suggestion of a like nature, though the President of the Board of Agriculture undoubtedly made attempts to devise some test which the cultivator would have to meet if he were to receive benefit from the guarantees. It was argued that there was no great likelihood of the guaranteed prices becoming payable, that what was wanted above everything else was simplicity and certainty, and that an expectation had been aroused that everyone would get such benefit as is to be got from the guarantees whether he grew much or little, and that discouragement, and, therefore, perhaps, a decrease of effort would follow if this expectation was seriously modified. Finally, it was pointed out from the Government point of view that there was some sort of test already in the Bill in that the payment may be withheld if the land is negligently cultivated, and that action may be taken under Part IV. of the Act, to which we shall come presently, if land is being badly cultivated. The controversy is closed for the present. In it, as in most others, there is merit on both sides. On the one hand it is true that farmers

have not exaggerated expectations of the benefits which Part I. of the Act will bring them, and that it might have been a serious discouragement to them in their task of corn production had the scope of the Bill been seriously narrowed; on the other hand the friends of the Bill would have had a powerful weapon for use in its support, and for the renewal of the guarantees which they will undoubtedly work for, if they could have stated that it provided that no share of the taxpayer's money should go to anyone who had not made a definite and special effort to increase the production from his holding.

The second question that arose, whether payment should be on the basis of quarters or acres, was more a difference between different classes of corn growers than between the agriculturists and the rest of the community. It was well argued in the House of Lords. The Government were in the difficulty that they changed their scheme while the Bill was going through. As drafted, the Bill proposed to guarantee a minimum price for each quarter produced and sold off the farm, and this proposal rested on the commonsense basis that as the object of the Bill was to increase the amount of corn for human food it was perfectly reasonable only to pay on what came into the market, and, therefore, had a good chance of going into human consumption. But then came reflection:—there is five times as much oats grown as is sold in market, but if there was any chance of getting anything by selling it in the market, would it not pass through the market even if it somehow came back again to the same farm? Might not some of it even pass through the market more than once? The number of acres a man grows is a very definite fact, which can be checked by impartial persons during many months of the year:—whether the grain which he threshes or sells has come off the acres is not quite so certain, and Ireland (which those who had these doubts were thinking of) is not the only part of the United Kingdom in which, as Mr. Prothero said, doing the Government is as good a sport as steeplechasing. So there was much to be said for paying per acre grown, not per quarter sold. The big men in the Eastern counties, however, did not much like the change. Were they whose soil and climate produced five quarters of wheat to the acre only to get the same as the farmer in the West who grew three or less? The final reply was that they were, and the arguments which settled it were that the Bill as originally drafted would be difficult to work and easy to evade, that it did not sufficiently look after the small man and the poor land, that paying per acre and not per quarter would encourage men to grow the best milling strains of wheat,

though these are not the heaviest yielders, and last, and most important, that as in the coming season the War Agricultural Committees would settle what land should be broken up and put under grain crops, it would be hard to penalise the farmers if this land produced a very low yield.

The second part of the Act establishes a Wages Board to fix minimum rates of agricultural wages. The most important points to be noticed in connection with this provision are (1) that able-bodied men employed in agriculture must be paid from the passing of the Act (August 21st, 1917) wages equivalent to a wage for an ordinary day's work of 25s. a week, and will be able within three months of the fixing of the minimum rate by the Wages Board to recover wages up to this standard. (2) A workman who is affected by any mental or other infirmity or physical injury which renders him incapable of earning the minimum rate may be granted a permit exempting him from the provisions of the Act if the Wages Board is satisfied with his case. (3) In fixing minimum rates the Wages Board shall secure for able-bodied men wages which in the opinion of the Board are adequate to promote efficiency and to enable a man in an ordinary case to maintain himself and his family in accordance with such standard of comfort as may be reasonable in relation to the nature of his occupation.

These and other provisions as to the function of the Wages Board will, it is universally admitted, be extremely difficult to bring into efficient administration. Hitherto Wages Boards have in general been a great success, but they have been set up in cases in which industries have been conducted under fairly uniform conditions, and in which the main task has been the comparatively simple one of fixing piece-rates which will give the worker a living wage. Agriculture, though universal, is an intensely varying industry, in which each district, often each parish, and almost each farm, has a custom of its own as to conditions of employment, for which there is generally some fairly good reason. To make a satisfactory settlement of wages to suit all these variations in conditions will be a task that will need very great patience and a high degree of mutual understanding and consideration between employers and employed. Much will depend upon the composition of the Wages Board, and, perhaps, still more on that of the District Boards, of which there will probably be one in each of the larger counties; and the committees which they will send round groups of parishes to make enquiries, and to decide upon exemptions will have a most delicate task. I think it will be found that one of the chief difficulties at first will be caused by the absence of organisation

on the side of the workers. During the three years that I was responsible for the adjustment of labour difficulties in connection with direct employment or contract work for the Army I found it almost a necessary condition for the satisfactory settlement of disputes that there should be a well established Trades Union respected by employers and trusted by its members. I believe, therefore, that employers will be wise in their own interest in no way to oppose the organisation of their labour by local leaders among the labourers, and that the labourers will be wise not to regard their leaders with jealousy or suspicion. A great many of the best farmers will, I am sure, welcome an authoritative settlement of wages questions. And however irksome the operations of the Boards may at first be found to be by some among them, they must console themselves, if they can, by reflecting that the setting up of the Wages Board system was no sudden device of politicians, in order that there should be some set-off in the interests of labour to the guarantee of minimum prices, but was a policy determined upon before the war and on which all parties were in substantial agreement. All who had before the war any real knowledge of rural conditions were agreed that the low rate of wages in great parts of England was not only keeping agriculture in a low state of development, but together with bad housing was smothering vitality and energy out of village life. Though for ten years before the war agriculture had been becoming more prosperous, little of the extra prosperity had been going the labourer's way, as the rising cost of living pretty well balanced increased cash wages. Emigration of the best men from the country went on steadily, and a vicious circle was established in that poor wages and conditions produced a type of worker which sometimes was not worth better wages, and sometimes could hardly have taken advantage of better conditions had they been established. This condition of things must be broken through if our home country-side is to be a strength to the Empire. Agricultural labourers who have served with the Forces will have learnt that it is not so difficult to move from one place to another as it may have seemed before the war, and only the certainty of good wages will bring them back. And we need a large new agricultural population in addition to what we had before, and only a certainty of good wages and conditions will attract it. This, at any rate, was the general feeling. So there was no dissentient voice in the House of Commons as to the necessity of minimum wage legislation. But there was acute controversy there as to what the minimum ought to be. The Prime Minister had announced 25s. in February, but had given no justi-

fication of the figure, and under these circumstances the House of Commons did not quite like being asked to confirm it. The main arguments for increasing it to 30s. were:—(1) that though 25s. is expressly stated to be only a minimum it will almost certainly be treated as a standard, and that 25s. at war prices can buy only what something under 15s. bought before the war. (2) Consequently if three or four shillings in pre-war values were to be deducted from the cash wage for rent and allowances the residue of something like 11s. at pre-war values would (to say the least of it) not be enough to attract new workers to agriculture. (3) That as the centre of all rural difficulties was housing—a difficulty which can only be solved satisfactorily when tenants can afford to pay a proper economic rent for their cottages—there was a chance of solving this difficulty by so fixing the wage that a full and proper rent could be deducted for the cottage, which is not possible if the wage be only 25s., as long as prices remain above their pre-war figure. On the other hand it was argued: (1) that farmers had accepted the Prime Minister's figure and would consider it almost a breach of pledge if it were increased; (2) that in spite of war costs of living, the cash wage, with allowances, was still a good deal less than 25s. in many cases, and that, therefore, the 25s. guarantee would be a real help to the labourer; (3) that the housing question could not be settled in a Corn Production Bill but must be dealt with gradually and at a later date; and (4) that if the Government were beaten on this issue they would resign and there would be a General Election. It would not be right for me in this article to debate the question further. The real difficulty in dogmatising on one side or the other lies in the impossibility of saying with certainty what will happen after the war. *If* the Wages Board takes 25s. as the standard rate, *if* industrial employment is good after the war, *if* owing to an inflated currency or other reasons prices do not return to anything like a pre-war level, then it is to be feared that lack of efficient labour will continue to be a serious handicap to agriculture. *If*, however, prices quickly return to a pre-war level, and agriculture, owing to trade depression, is the chief claimant for the available labour, and *if* wages are maintained at some figure well above the minimum the fear that the land will be starved for lack of men to work it may not be justified. Time alone will show which side in the controversy will be able to say "I told you so" to the other.

We shall have to wait also before we can tell which side was right in another controversy which arose over wages, in the House of Lords. As the Bill left the Commons, and in the form it now

takes as an Act, it is the Central Wages Board which has to issue a permit to the workman who is not able-bodied exempting him from having to be paid at not less than the minimum rate. Presumably the District Boards will set up sub-committees to examine into these questions parish by parish, and will report to the Central Board in order to get their recommendations approved. But the House of Lords considered that these proceedings would be lengthy and complicated, and possibly would operate unfairly upon old and infirm workers. Lord Lansdowne proposed that after minimum rates had been fixed, an employer, who employed a workman who was not able-bodied at a rate less than the minimum should send to the District Wages Board a copy of the agreement that he had made with the workman setting out the particulars of the case. That committee would then have an opportunity of revising the rate of wages agreed to, but when they had approved of the agreement it should be binding. Lord Curzon undertook that the Government would regard this alteration of the Bill with a favourable eye, and that the President of the Board would support it in the Commons; but when it reached that House the President moved to disagree with it, and it was accordingly rejected. The reasons for its rejection were that it seemed to allow a sort of contracting out, which is not popular in the Commons, and also to remove a very important class of labour from the judgment and control of the Central Wages Board. It may be thought that in rejecting the Lords' alternative the Commons preferred principle to convenience of working, and as I have suggested time will show.

The third part of the Act forbids the fixing of rent at, or the raising of rent to, an amount exceeding what could have been obtained if guaranteed minimum prices for wheat and oats had not been established, and if in the opinion of the tenant the rent has been so fixed or raised he can, within a year from the commencement or variation of the tenancy, require the question to be referred to a single arbitrator, in accordance with the provisions of the Agricultural Holdings Act, 1908. It may be well as a comment on these provisions to give some illustrations of what a landlord may and may not do as the law now stands. He may think that a farm has, according to the custom of the estate, been under-rented in the past, and may put the rent up to the highest that a farmer would be willing to pay were Part I. of the Corn Production Act not law. He may say that the value of the farm has been increased owing to ploughing up, and put up the rent accordingly, just as if the value of the farm has been decreased he will be expected to put the rent down. He may co-operate with his tenant in trying to

increase the productivity of the farm, and may undertake drainage or build implement sheds or cottages, and for all his expenditure he can get an economic return in the shape of increased rent, if his tenant will pay it. But he may not fix a rent with regard to which an arbitrator would say: It would not have been so high by so many pounds unless the tenant had been guaranteed by the State certain corn prices between 1917 and 1922. In fact, except as regards the particular point that the landlord may not exploit the tenant's actual or prospective gain under Part I. of the Act, matters are left just as they were before. This will, I think, be generally considered reasonable enough. The Act has been described as a long step towards Land Nationalisation, and may, indeed, prove to be so. If the nation definitely sets its hand to securing from its land the greatest production of food, and the best maintenance of human beings it will expect landlords to become active partners in bringing about this change. If they do not do so, if they put up with slack tenants and do not in every way study how to make agriculture a better business, and the country-side a place of life in its highest and fullest sense, they will inevitably be superseded, and become mere receivers of a fair interest upon what they have put into the land. But there was no excuse for beginning this sort of change in the Corn Production Act. It was felt that landlords should have every inducement to put brains and money into their business by being able to get a fair return upon what brains and money can accomplish. And therefore no serious attempt was made to restrict their powers except by securing that such inducement as exists in the guaranteed minimum prices shall remain as Parliament intended it to be—an inducement to the tenant—not a dole to the landlord.

The last part of the Act with which we need here be concerned gives the Board of Agriculture certain powers to enforce proper cultivation. Taking first the simplest case dealt with, the Board, if they think that any land is not being cultivated according to the rules of good husbandry, may serve a notice on the occupier requiring him so to cultivate it, and may set aside covenants or conditions in contracts of tenancy so that he may do so. Then, if he is aggrieved, he may appeal to a single arbitrator. If he does not appeal, or if his appeal fails, and he does not carry out the requirements of the Board, they may, if the occupier is a tenant, either authorise the landlord to determine the tenancy, or themselves determine it, and if the occupier is the owner, themselves enter on the land and either themselves cultivate it or let it for any term not exceeding five years. Any person interested in land

affected by these provisions may recover any loss which he has incurred through the action of the Board, such loss to be determined in default of agreement by a single arbitrator. This is the procedure intended to be followed in such cases, for instance, as when land is neglected, and allowed to get into a foul state, and no proper attempt is made to keep down nettles and thistles. No doubt in some form or other the County War Executive Committees and District Committees will be made permanent, and no doubt also the Board would in these cases act on their advice, and under it it should be possible to do a great deal of good in some districts. But the Act gives the Board further powers, parallel to these but not exactly similar in their working, with regard to land as to which they are of opinion that "for the purpose of increasing in the national interest the production of food the mode of cultivation or the use to which the land is being put should be changed." In this case the person aggrieved also has an appeal to a single arbitrator, but only on the question whether it is undesirable in the interest of food production that the change should apply to *any portion of* the land. The other powers as to entering on the land, and compensation for damage, are the same as in the first case. This is no doubt the power which the Board would exercise if they think it necessary in the interests of food production, to turn large areas of grass land into arable or to have land which is used for sport, or not used at all, brought under cultivation.

A further clause under this part of the Act concerns rabbits and vermin. Under it, where the Board of Agriculture are satisfied that crops, trees, or pasturage, are being damaged because the occupier fails sufficiently to destroy the rabbits or vermin, they may give him a reasonable chance to destroy them, and if he does not do so, may authorise someone else to enter upon the land for the purpose, and recover from the occupier the net cost of the proceeding. This will apply both in cases in which an owner allows rabbits to do harm by getting out of coverts on to farm land, and to cases in which a farmer allows too many rabbits on his farm. I will only say that I believe there is plenty of room for making use of the clause in both directions in many parts of the West of England.

The part of the Act dealing with powers to enforce better cultivation was largely remodelled by the House of Lords, their scheme being accepted by the Commons. As the Bill left the Commons the powers of the Board were as wide as it was possible to make them. They could act in any case in which they thought land was not being cultivated in the best interests of the country, and, though

there was ample provision that anyone injured by their action should receive full compensation, there was no appeal to an arbitrator against their notices to cultivate. It was thought that they would be soundly advised by local committees on which farmers who knew what could reasonably be required would be well represented, and that no appeal to an arbitrator, who would know much less about it than such local committees, would be necessary. But the Lords limited the class of cases in which the Board could act, they gave an unlimited right of appeal in cases in which the Board claims that cultivation is not in accordance with good husbandry, and a limited appeal, as described above, in cases in which the Board wish to change the method of cultivation in the interest of food production. Indeed, on the last point the Government were beaten, the amendment being carried against the strong opinion of the President of the Board of Agriculture, who, nevertheless, moved in the Commons that it should be agreed to.

There will, I think, be two well defined and sharply contrasted policies with regard to the administration of this part of the Act when the war is over. During the war we have, on the whole, submitted to the requirements of the County and District Committees, backed up by the Board of Agriculture, with a fairly good grace. But when the danger of the food shortage is over there will be many, like speaker after speaker in the House of Lords, who will see no reason why farmers should in any way modify the custom of the country-side which they have found convenient and fairly profitable in the past, just because "faddists and theorists" from Whitehall want to have changes made. There will be others who will insist that the only real return which the nation can get for the heavy liability of the guarantees will be a real control over methods of cultivation, exercised through the Minister of Agriculture for the time being. In particular they will urge that there is a great deal of land, over and above anything we may plough up during the war, which will produce large supplies of food in grain and potatoes, and support a large increase in the rural population without in any way lessening its powers of supporting stock. They will advocate a thorough application of this policy on the ground that agriculture produces more wealth for each person employed than any of our great staple industries. And they will think it quite fair to the farmer to require him to modify customs, even though the new methods give him more trouble than the old, as long as they can show that the prices fixed give the farmer a fair return for his capital and his efforts. With regard to appeal,

they will very much distrust the appeal to the ordinary local arbitrator who will seem to them almost bound to be an opponent of the new methods, and they will prefer that any appeal from the action of the Minister should be to the House of Commons, and that so long as he retains the confidence of the Government, and the Government the confidence of the House, the decisions of his department should be acted upon.

I will only here venture to express one thought, that as things are there is some danger that the two views which I have described may tend to become the views of different political parties, one playing up to the farmer and promising to administer this part of the Act very gently, if at all, the other playing up to the farmers' enemies, who are many, and promising a vigorous administration of it in the interests of food production and human maintenance on the land. The conflict and confusion resulting from anything of this kind can be better imagined than described. This danger could not, perhaps, have been altogether avoided, but much might, I think, have been done had it been possible to adopt in general outline and by general agreement a national policy of food production not limited to the war period. If that had been possible the administration of different Governments would have been measured not in terms of opposite policies put forward by opposing interests, but by the degree to which they were adhering to a policy which both farmers and landowners and the rest of the community had generally accepted as fair. I believe that something of the sort is still possible if the right steps are taken. Mr. A. D. Hall, the permanent Secretary to the Board of Agriculture, has calculated that whereas, according to a Committee of the Royal Society, our home production of food only amounted to 42 per cent. of our consumption before the war, we could if we ploughed up about seven million more acres of grass land put ourselves in such a position that in war we could maintain ourselves on a war diet without external supplies. If these calculations could be worked over and considered by a body composed of some of our best county administrators, some of our most experienced farmers, and some of our most practical scientific experts and economists, with a view to producing a practical scheme of operations, we might, by adopting and working out their report, raise our food production policy above the sphere of party politics and the wrangling of interested parties—to the immense gain of the nation as a whole. No work would be worthier of our present Ministers of Agriculture and of Re-construction than the initiation of such a course of action.

The Corn Production Act is not perfect, and could not be expected

to be so. I have alluded to certain possible criticisms and certain difficulties that may arise in the future. There will, no doubt, be many others that we cannot now foresee. But I believe that it marks a real step forward. Its motto is "Security." Security for the farmer that he may boldly and confidently advance on progressive lines, and no longer play for safety on the easiest road, as he has been almost bound to do hitherto. Security for the labourer that his work—"skilled" and "indispensable" as every farmer has lately so loudly proclaimed it to be—will no longer be a residual occupation in which poverty prevents efficiency, and life in its true sense is impossible. Security for the State that its land shall be so used as to produce the best possible types of men, women, and children, and such an abundance of food supplies as shall preserve us from any future risk of hunger.

III.—THE STORAGE OF ENGLISH WHEAT.

By F. W. Saxby.

War has created many important and vital problems which are at present occupying the nation's attention, and next to victory itself comes the question of our food supply. Owing to submarine losses and the absorption of shipping for militant purposes, the country finds itself compelled to put increased areas of pasture-land under cereal crops, and the question at once arises what cereal is best suited to all the existing conditions, natural and economic. It is the writer's opinion that this point will be decided, not by the farmer but by those in authority, in favour of wheat; at any rate for the greater bulk of cereal food to be grown during the continuance of the war. Most of the crops of English wheat grown in excess of pre-war quantities will have to be stored, as I hope to show a little later on that our millers will be unable to absorb at once any serious quantity above that to which they have been accustomed in the past. How that excess is to be stored is the subject of this article.

The Farmer.

It is going to take the farmer all his time to grow the wheat required of him. Those who, in the past, have devoted their land largely to stock-raising and dairy farming, will find themselves

short of the tackle necessary to effect the conversion of their land to the new use, and how is the tackle to be got? But, supposing that he gets both the tackle and labour to sow and reap his wheat, are we to look to him to take any serious part in storing it? The suggestion that he should do so is economically unsound, for, unless he is assisted financially, the loss of interest on his capital will alone turn him against wheat storage. The only practical way open to him is to store his crop in stack, for he has neither the room nor the conveniences for attempting anything else. To store wheat in stack great care and climatic conditions that do not often arise are required. The farmer's business is to grow for sale, and having done so, to realize his harvest. I think it can be shown that we need only look to the farmer to produce and market his grain, the surplus of his crop being left to others who are specially equipped for the business of storing it.

THE MILLER.

The millers of this country, and especially those with large mills at or near the ports, rarely or never grind one kind of wheat only. It is a fact that apart from very special purposes the flour so produced would be difficult of sale, and would not produce a loaf acceptable to the public taste. It is only by blending wheats gathered from many parts of the world—an operation requiring great skill and judgment—that the miller is able to produce regular grades of flour that will satisfy his customers all the year round. He has to set off the characters of one kind of wheat against opposite characters in another, and it is an unfortunate fact that, apart from its high colour, English wheat yields a flour that is poor in strength, difficult to work in the bakery, and does not make a satisfactory loaf. It is equally unfortunate that English wheat does not behave well in the mill. Its high percentage of moisture, varying as it does from 15 to 19 per cent. according to conditions, is a serious drawback. Before the war this country produced one-fifth of its wheat requirement, the other four-fifths consisting of foreign kinds in which the natural moisture varied from 10 to 15 per cent. It is a common practice with millers to "condition," *i.e.*, to wash, drain, dry and mellow these wheats to a uniform moisture of somewhere near 16 per cent., in which state the grain is put on the mill. With the exception of very dry varieties of wheat such as Indian (natural moisture 10 per cent.), and the already too wet English, this "conditioning" is done on the mixture. The Indian wheat (Karachi, Bombay, Calcutta) is simply washed apart and put to mellow without

going over the drier, but the English wheat is much more troublesome. If very clean, it is put directly on the drier, but the great excess of moisture is rarely driven off, as it involves a prolonged use of the apparatus and the application of extra steam to the heater. In dirty lots the necessity to wash increases the trouble, and to the extra expense incurred in special drying and separate handling must be added the unsatisfactory behaviour of English wheat in the mill machinery. The modern roller-mill has been constructed with a special view to the grinding of the harder imported varieties of wheat, because by careful conditioning they can be made to yield large proportions of semolina—from which "patent" grades of flour are obtained. The period allowed for "mellowing" is not, for commercial reasons, long enough to equalise completely the moistures of the various kinds of grain in the mixture, and the English, normally soft and starchy, is invariably wetter than its fellows. It gives in consequence little or no semolina, but early in the process splits up into "break flour" which, being of a greasy nature, clogs up the grinders and bolting-cloths specially adapted to the harder and freer varieties in the mixture. Under such conditions how can we expect the miller to grind greatly increased quantities of English wheat, all thrown upon him in the course of a few weeks following harvest. The miller cannot store it—his storage capacity is only sufficient to provide him with grain during those intervals that must lapse between the arrivals of his cargoes or the deliveries of parcels from public granaries. He—like the farmer—knows his own business best, and storing wheat—especially English wheat—pure and simple is not part of it.

MANUFACTURED.

Let us suppose, for the sake of argument, there are in the country sufficient mills to grind, in an unmixed state, all the surplus English wheat that can be produced (by which is meant all that cannot be at once absorbed for mixing in the ordinary course of the trade), and let the natural moisture in it range from 15 to 19 per cent. To reduce this to a "condition" of 16 per cent. (it cannot be milled much over that) for grinding, will create the difficulties and expenses already enumerated—especially if washed—and the flour from it will leave the mill with a moisture content of from 14½ to 15 per cent. according to atmospheric humidity, etc. English flour in such a condition will not keep in the sack for more than two or three months, according to season. By that time caking, mustiness, and acidity will have set in, and render the product unfit

for bread making. To dry the flour further as made, involves the use of special plant possessed by very few millers, and such plant is now difficult or impossible to obtain. To dry flour to a very low moisture percentage and store it for long periods—even if that could be done—involves such financial difficulties that we may at once dismiss it as unworkable. With the same object in view, suggestions to manufacture the flour into biscuits, or to flake or shred or otherwise cook the grain must be abandoned as economically unsound. Let a reader compare the dearest bread to-day with the cheapest biscuit before the war, and, after allowing 40 per cent. for water in the bread, the price of the biscuit puts it entirely out of the question. We have in this country no shredding or flaking plant capable of dealing with the situation, and, even if we had, the same objections would obtain.

THE GRANARY.

So far as I can see, the problem will be answered by the granaries. Experience has proved that foreign wheats in which the natural moisture does not exceed 13½ per cent. will, with care and attention, keep for long periods in silo, and those kinds with 11 per cent. and under require little or no attention. It will be evident therefore that moist English wheat will not keep sound in warm weather for periods of even a few weeks in the best-appointed silo ever made. The storage for such periods of foreign wheats, whose natural moistures range from 13½ per cent. to 15 per cent., is attended with difficulty. In spite of repeated "turning," heating of parcels does occur and is the source of dissatisfaction and loss to the trade. The home-grown grain, with a moisture average of 17 per cent., would, under similar conditions, simply sweat, heat up, run into sprouts and rot in a very short time. In point of fact, the silo keeper has never been called upon to store English wheat for long periods and can have no experience of it.

I will now call attention to the Indian wheats to which reference has already been made. They are the dryest that reach this country, with natural moistures averaging 10 per cent. When free from weevils they will keep in excellent condition indefinitely in silo, there being insufficient moisture to awaken any germinal activity or to promote any organic changes of a detrimental character. Indian sorts are in favour with the miller because they are easy to grind, make little break flour, and yield an abundance of semolina for reduction to " patent " flours.

A SUGGESTION.

The crop of Indian wheat, under normal conditions of season and transport, reaches this country at a period fairly coincident with the marketing of the English crop. It is suggested that millers should be free as formerly to buy what English wheat they require for immediate and near use, and that the remainder be bought in by the brokers for Government account and stored in a state of admixture with an equal quantity of sound Indian—which must be imported by the Government and reserved for that purpose. These two wheats mixed and stored in silo will, in the course of a fortnight, have mutually adjusted their moisture content so that both kinds will contain 13½ per cent., being the average of 17 per cent. in the English and 10 per cent. in the Indian. In this condition the mixture will—with perhaps some little care—keep marketable until it is consumed by the millers in the ordinary course of their requirements. Should there be insufficient unweevilled Indian wheat available, other dry sorts such as Australian or Californian might be used.

The usual course of the markets will go on undisturbed, the farmer will be able to realize his harvest as he has done in the past, and the miller will be able to draw from the granaries a supply of "colory" wheat over a greatly extended period. The profit the miller formerly made out of the dryness of the Indian wheat will be compensated by the absence of an equal percentage of moisture in an equal quantity of English. The miller will escape the extra cost —experienced in the past—of separately conditioning these two wheats, for they will, at 13½ per cent. moisture, take their place with the other kinds in his mixture and respond to the same treatment.

As the acreage under wheat is always known in this country, there would be no difficulty in computing the excess of English and the reserves of Indian wheat to be stored. Our silo accommodation as it now exists should meet the situation, as the excess of English wheat to be stored will not, under the most sanguine expectations, exceed the shortage in imports occasioned by the war. The Government, in marketing the mixture, will not suffer from any loss of weight, for the Indian will take up what moisture the English wheat gives out; a slight adjustment of price will cover storage and broker's charges, and no one will be asked to find a penny.

For the sake of argument let it be presumed that sufficient of these dry wheats does not reach us, but goes, say, to the countries of our Allies. Under such circumstances Britain will find itself

forced to grow still more wheat, and some forecast must be taken should such extreme conditions arise. As less wheat is imported home millers will of necessity take more English, and although we have shown that millers can at some increase of cost deal with it, there will still be a large surplus for storing.

MALTINGS.

By the time such a condition of things will have arisen the amount of grain usable for brewing purposes will have been reduced to a minimum. This will leave the maltsters with little to do, and as drying on a large scale is one of the processes incidental to the brewing of beer, we might look to them to undertake the drying of a portion of the wheat in the maltings scattered about the country. It is suggested that the wheat, dried down to a moisture of say 13 per cent. by the maltsters, could be handed over to the silo keepers for storage—but, of course, such procedure would have its attendant expenses.

Presuming that only a portion of the excess crop were so dried, it would relieve the pressure in necessitous cases where farmers were unable, for lack of conveniences and other local reasons, to hold their wheat in stack for long periods.

As already stated, stacking is a risky business in view of our uncertain climate, but if we are to be reduced to anything approaching famine conditions, risks and expenses will have to be shouldered.

Let it be supposed that a large proportion of our wheat crop has to be stacked. By the time such an unlikely state of things could arise, all foodstuffs in the country will be under control, as will also be the growing of cereal crops, and the controllers will have to exercise their authority in the matter of threshing, so as to permit no more than the necessary quantity of wheat to come into the market each month. Such a system of restricted threshing will have to be counterbalanced by fixed minimum prices advancing along the seasons so as to recompense the holders of stacks in proportion to the delay imposed upon them in threshing. He who holds his wheat longest would get the best price.

The writer would like to say, however, that he is unable to see in the conditions that obtain to-day, any possibility of such pressure from the enemy as will prevent the importation of sufficient dry wheat for storage purposes already alluded to.

Appended is a list of natural moistures of such wheats as are usually milled in this country.

NATURAL MOISTURE OF WHEATS.

Karachi, Bombay, Calcutta, Australian, Californian ..	9 to 10 per cent.
Chilian, Egyptian, Hard American Winter Wheat	10 to 12 „ „
Plate, Soft American Winter Wheat	11 to 13 „ „
Best Manitobas, Durum, Russian Ghirka	12 to 14 „ „
Danubian, Azima	13 to 15 „ „
Tough Manitobas	14 to 16 „ „
English	15 to 19 „ „

IV.—INSECT PESTS OF HOUSE AND STORE.

By Harold Bastin.

(Author of "British Insects and How to Know Them," etc.)

THE AWAKENING.

Four years ago, the people of these islands were living luxuriously—not to say wastefully. A hundred and one things that lie well beyond the line of bare necessity were easily obtainable, not only by the wealthy and well-to-do, but by those vast masses of our population whose unit is referred to familiarly as "the man in the street." Even the agricultural labourer expected—and received—a far larger share of life's good things than fell to the lot of his forebears of half a century back. For food, clothing and the means of domestic comfort were all cheap and abundant; nor was it possible to suggest any plausible arguments why this pleasant state of things should not continue indefinitely, and grow from more to more. In a word, we seemed to stand upon the very threshold of the golden age—to be forcing want and anxiety finally into the background. Small wonder that we had abandoned most of our habits of thrift, and were inclining more and more to a happy-go-lucky mode of existence. The narrow end of cornucopia is apt to be forgotten while its wide mouth pours riches into one's lap!

Then came the great war. We thought at first that it must soon be over; or that if, by an unhappy chance, its horrors should be protracted for a year or two, our unique resources would surely withstand the strain. "Business as usual" was our cry, uttered

almost gaily; and in our hearts we hoped, and at times actually believed, that not only our business, but our pleasure—down to the smallest fads and foibles of our everyday life—would be unaffected by the calamity that had fallen upon mankind. We rallied to support the old order of things, determined to uphold the already tottering fabric until the storm should be overpast. But by slow degrees the knowledge was born in upon us that we—the proud Britains—must either dispense with all our luxuries, and tighten our belts to the last hole, or abandon our fixed determination to "win through." Of course, there was grumbling; but—equally of course—there was no hesitation between the alternatives. Straightway we entered upon a period of our national history when the cruder aspects of domestic economy were forced into prominence. Each day we asked ourselves bluntly such questions as—Do I eat too much? Can this old coat be made to serve me for another three months? or—perhaps most frequently of all—How can I contrive to *save?*

THE CAMPAIGN AGAINST WASTE.

At first, this campaign against waste was thought to be a temporary expedient, destined to continue for the duration of the war, and possibly for six months thereafter. We now realise that any such diagnosis of our case must be regarded as little better than suicidal optimism. Experts appear to agree that, in 1914, the whole civilised world was rapidly approaching a period of food-shortage; and that even had there been no war, we should at the present date already have experienced the strain of rising prices. Naturally, the war, by transferring millions of men from productive to non-productive activities, has rendered desperate a condition which, in normal circumstances, would probably have been slowly righted without serious difficulty. But as matters stand, the crisis to which we have come is acute, while the period of convalescence promises to be protracted and tedious; for, when the war is over, and peace is again restored to the world, we shall still have the enormous war-wastage to make good. And this will take time. How long, none is at present able to estimate.

Clearly, therefore, we cannot look for a speedy return of the good old times when the supply of food-stuffs and domestic comforts was unfailingly abundant, and living was cheap. So the two-fold problem of our immediate past must remain with us as the problem of the future. We must continue to foster production, speed-up and improve means of transit, and equalise distribution. We must also persevere in the practice of those principles of thrift that the

exigencies of the war have forced upon our attention. Doubtless the need for rigorous economy will become less urgent as the years pass, and in the end we may drop back into our old habits of comfortable carelessness. It may well be, however, that we shall learn unforgettably the great lesson that needless and avoidable waste is always and at all times—" bad business."

OUR NATIONAL PROBLEM.

Reverting to the problem which continues to face us, we perceive clearly that the special part of it that appeals most strongly to the plain man and his wife concerns thrift. Under modern conditions, we cannot all be first-hand producers, even in a small way; nor can we all assist in the work of transport and distribution. But we can all economise. We can contrive, each in his own domestic circle, that there shall be no aimless squandering or avoidable leakage of supplies. And in so doing we shall not only help the State. We shall also help ourselves to tide over that period of lean years which assuredly lies ahead. That the urgency of these arguments is recognised by our Government is evidenced by the various schemes that have been set on foot with a view to influencing popular sentiment. Thus, we have been invited to attend all manner of exhibitions, classes and lectures, whose aim has been to render thrift admirable in our eyes, and to demonstrate the ease (subject to knowledge) with which methods of thrift may be put into practice. We have been shown, for example, that brown boots may be polished with banana skins; that apple peelings make excellent jelly; and that dainty dishes may be prepared from kitchen scraps which we formerly regarded as refuse, fit only for the dust-bin. Nothing has been deemed too trivial to warrant attention; and it is this fact, in particular, that has led the writer to ponder upon a source of wastage to which every household in the land is liable, viz., that due to the depredations of certain insect pests.

LOSS CAUSED BY HOUSEHOLD INSECTS.

We all know something of the loss which may be occasioned by such vermin as rats and mice; but this is probably far less serious, in the aggregate, than that which must be charged against household insects. So little is this leakage recognised that many people express surprise when their attention is called to its existence. But consider a case—imaginary yet none the less true to life. At the approach of winter, your wife informs you that your best over-

coat—new last season, is so badly moth-eaten that it is all but worthless. Even the dealer in old clothes will not look a second time at it. The same fate has befallen your wife's fur muff, and some of the children's woollen garments. On another occasion you discover that your store of bacon and hams is overrun by the "larder beetle," and that much of the meat has been rendered unfit for human food; or that the "paste beetle" is swarming among the biscuits, and the "mealworm" among the flour; or, again, that the legs of your valuable pianoforte have been invaded by the "furniture beetle," which is reducing them by slow degrees to a yellowish powder that issues from tiny holes in the woodwork. Remember, now, that this kind of thing is happening constantly, year in, year out. Put the average loss per household as low as £2 or £3 per annum only, and multiply this by the number of households (if you know it) in the United Kingdom. You realize at once that the yearly loss imposed in this way upon the community must be very considerable, running, in fact, into millions of pounds sterling. Staggering—is it not?—that insects should prove capable of robbing us to this extent in our very homes. But it is even more staggering, when one comes to think of it, that we should submit meekly (as most of us do) to the impoverishment. Because the loss is not really inevitable. It—or at least a large proportion of it—might be prevented if we would acquaint ourselves with a few little facts concerning the habits of the insects in question, and then adopt common sense measures for our protection. The trouble is that few of us know where to turn for reliable information; and, even if we knew, most of us would probably fail through lack of time and opportunity to consult the numerous books and pamphlets which deal with various phases of the subject. The present writer has, therefore, ventured to bring together, in the concise form of an article, such facts concerning our commoner domestic insects as seem likely to prove most useful to the average householder. No claim to originality is advanced, although, in numerous instances, the statements made have been tested by personal observation and experiment. With regard to the literature consulted, Mr. Edward A. Butler's work* published some twenty-two years ago, may be strongly recommended to those who find pleasure in biological details attractively set forth. The author tells us little, however, of the means which may be employed for suppressing our undesirable co-tenants. Still, the book is a good one, and apparently has the distinction of being the only work dealing exclusively

* "Our Household Insects." Edward A. Butler. Longman, Green & Co. 1896.

with British household insects, although several others devote more or less adequate sections to this theme. In America, there has recently been published an excellent and thoroughly practical treatise entitled "Insects Injurious to the Household"*; but naturally, a large part of its contents relates to pests (such as the Argentine ant) which are unlikely to trouble us on this side of the Atlantic.

"Straight-Winged" Insects.

Most of the insects that frequent houses and stores in this country belong to one or another of three important orders, viz., Orthoptera ("straight-winged"), Coleoptera ("sheath-winged"), and Lepidoptera ("scale-winged"). The first of these orders was named Orthoptera by Linnæus because, in its most typical members, the chief nervures or "veins" which support the wing membrane follow, on the whole, a less sinuous course than is the case with most other insects. The order comprises very numerous forms, of which the cockroach and the grass-hopper are examples, as well as the curious "walking stick" insects, which are confined, almost exclusively, to the warmer regions of the globe. Dr. Sharp tells us that the lowest number at which the species of Orthoptera now existing upon the surface of the earth can be estimated is 10,000, but adds that this is probably much under the mark. Yet comparatively few species (about 40 all told) inhabit Britain; and of these not more than five, at most, fall within our present purview—to wit, four kinds of cockroach, and the house-cricket.

Cockroaches.

Probably few people know that we have three indigenous British cockroaches, at least one of which is fairly common in wooded districts. But these small wildings are without obvious economic importance, and are never found in houses. Our harmful cockroaches are all "introduced species," although the best known and most abundant one (*Blatta orientalis*) probably came to us in the very early days of ocean-borne commerce, having travelled, apparently, from the East, in the first instance. This is now our "common cockroach," often called the "black beetle"—possibly because (as some wag has said) it is neither black nor a beetle! Its colour varies with age and sex from pale, almost whitish, yellow in the

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***"Insects Injurious to the Household." Glenn W. Herrick. The Macmillan Co. 1914.**

newly hatched young, to dark mahogany brown in the adult, the mature female being decidedly darker than her mate. The females also differ from the males in other respects, notably in their virtually apterous condition, the wings being reduced to small, functionless plates, hinged to the second and third thoracic segments. The male, on the contrary, has well developed wings, which, however, appear to be somewhat small in proportion to its bodily bulk; and it is noteworthy that the insect rarely attempts to fly. Indeed, the writer has never seen the male cockroach make use of its wings, even when thoroughly alarmed, and evidently exerting every effort to escape capture. (Figs. 1 and 2).

LIFE-HISTORY AND HABITS.

Cockroaches, in common with all other Orthoptera, undergo what is called an "incomplete metamorphosis" as they grow from youth to maturity. That is to say, they have no stages in their life-cycle which correspond to the caterpillar and chrysalis of the butterfly. When the young cockroach leaves the egg-shell, its identity is at once evident to the eye. Certainly it lacks wings, and is extremely small; but in other respects it differs little from the paternal guise. As growth and development proceed, the skin is cast periodically—some seven times, in all, it is believed; and the wings are formed gradually in anticipation of the final moult, after which they become functional. But, strange as it may seem, the complete life-history of the common cockroach has never yet been satisfactorily worked out. Observations made on captive insects have led some authors to conclude that sexual maturity is not reached until the fourth year after hatching. Yet, when we think of the rapid increase of these pests, such an estimate seems scarcely to be credited. Probably the true explanation will prove to be this: that the cockroach, like many other insects, can accommodate itself to circumstances in a remarkable degree, growing up quickly when the temperature is genial and food abundant, but adopting a "waiting policy" when its environment does not favour rapid development. Be this as it may, the fact remains that when cockroaches take up their residence in quarters suited to their needs, they soon multiply prodigiously, so that every available nook and cranny speedily becomes populated by them—assuming, of course, that no effort is made to check their increase. Yet because they are strictly nocturnal and excessively shy, they are seldom seen, save by those who come suddenly upon them after dark. Your premises may supply ample evidence, both to the eye and the nose, of cock-

roach infestation ; but so long as daylight lasts, and the members of your household are up and about, you will rarely see one of the offenders. Make a point, however, of entering the kitchen department suddenly, with a light, an hour or two after your family and dependants have retired to rest, and you will be amazed at the scurrying crowds of dark forms that rush precipitately to shelter. They pass the day in cracks and crevices, or beneath boxes, bags and matting—in fact, wherever they may lie hidden secure from cold. For they cannot tolerate a low temperature, and are quite unfitted for an open air life in our climate. In their hiding places the female cockroaches produce and conceal their egg-capsules, or oötheca ; for these insects do not deposit their eggs singly, after the common mode. The parent is provided with an apparatus which smoothly covers each batch of eggs with an envelope, which is at first pale in colour and soft, but subsequently becomes dark brown and assumes a horn-like consistency. The complete egg-capsule of the common cockroach is nearly half-an-inch in length, oblong, with rounded ends and base. Along the upper side we notice a sort of crenated ridge, which is formed by the swollen, closely compressed lips of the slit through which the young cockroaches effect their escape after hatching. Each oötheca (in the case of *B. orientalis*) contains sixteen eggs, arranged in two parallel rows of eight ; but the number of eggs in the capsule is not the same in all species of cockroach. Upon its completion, the capsule is carried about for a short period by the female, protruding from the end of her body ; subsequently it is deposited in some warm hiding-place. (Fig. 2.)

"GERMAN" AND "AMERICAN" COCKROACHES.

In most parts of the country, the Oriental cockroach is the only kind with which householders have to reckon ; but within certain areas two other species may be observed in considerable numbers. These are the German cockroach (*Phyllodromia germanica*), and the American cockroach (*Periplaneta americana*). The former apparently belongs to Central and Southern Europe, the latter to South America ; but both have spread widely, especially *P. americana*, which has become practically cosmopolitan in its range. The commonest pest cockroach in the States—that known as the "croton bug"—is no other than *P. germanica*. Herrick tells us that its popular name is due to the fact that "it was first associated with the water system of New York City supplied through the great Croton aqueduct. Very likely this cockroach had been living in this country long before, but the water pipes gave opportunity for

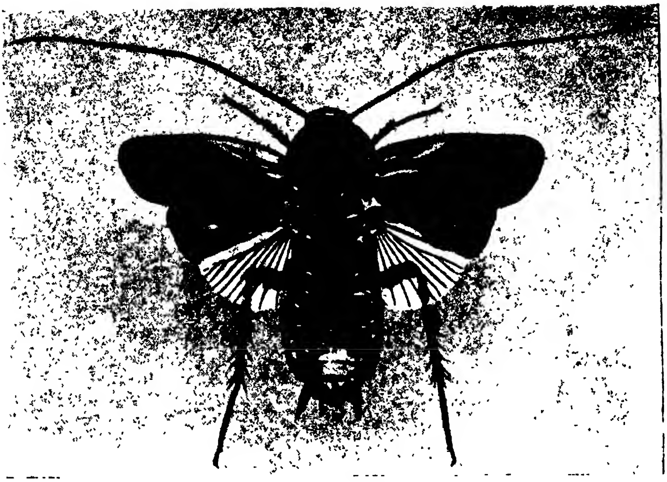

Fig. 1.—Male Cockroach, with the wings spread.

Fig. 2—Female Cockroach, with egg-capsule.

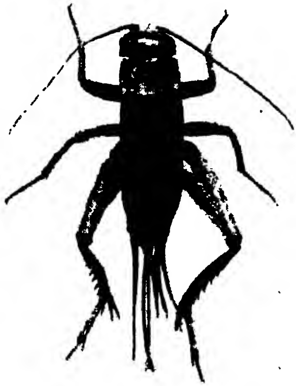

Fig. 3. —House Cricket (female).

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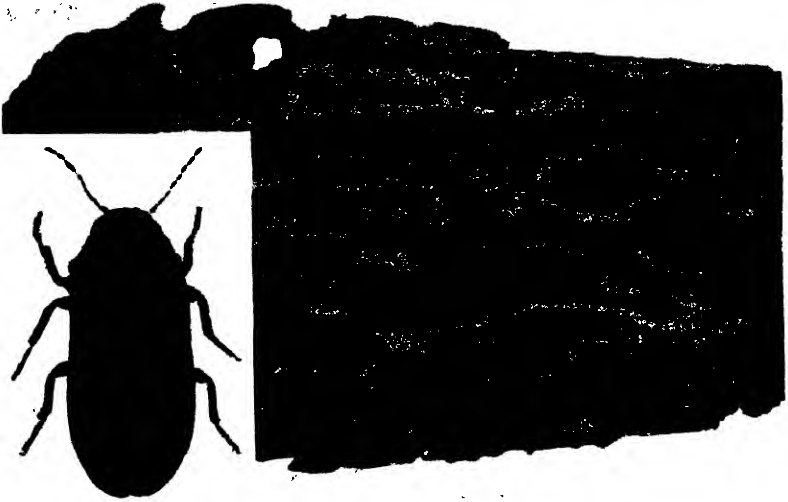

Fig. 4.—Oak timber riddled by *Xestobium.*
Inset.—The Adult Beetle (much enlarged).

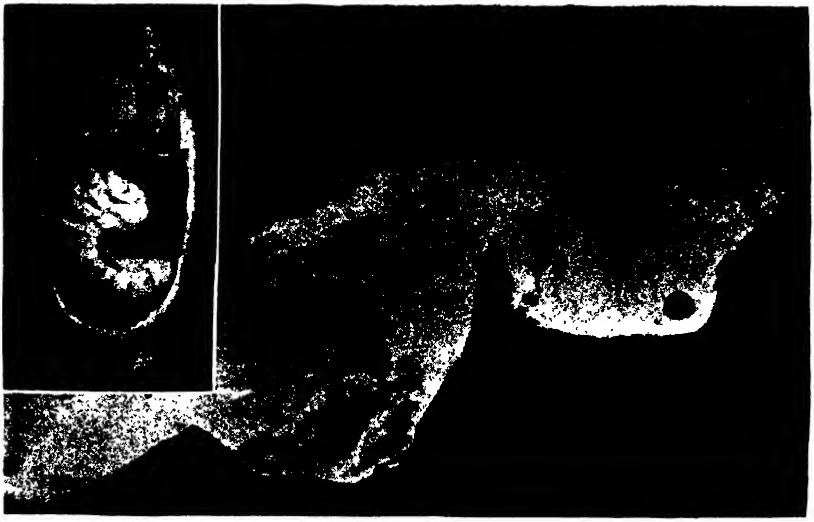

Fig. 5.—Ginger, attacked by the "paste beetle."
Inset.—Larvæ of "paste beetle" feeding in a wheat grain.

entrance to the houses and the accompanying dampness was much liked by the insects. It is a fact that these insects become numerous and greatly troublesome in dwellings as soon as a system of water-works is installed." From which it is argued that the German cockroach flourishes best in humid conditions, which is probably true, since in its wild state it is a woodland species. But the insect has certainly not "spread with waterworks" in Great Britain; for although both it, and *P. americana*, are numerous in many warehouses, restaurants and hotels, especially in London, and in some of the houses at the Zoological Gardens in Regent's Park, neither the one nor the other has so far achieved more than a local footing. Still, it is well to be on our guard against them, for cockroaches are exceedingly pushful and prolific, and there is reason for thinking that at least the American cockroach is slowly extending its range. Quite recently, the writer had news of it from a Midland firm of florists and nurserymen, in whose glass-houses it has become an "inveterate nuisance." We must remember, too, that fresh imports of living cockroaches continually reach this country with shipments of goods; and these new arrivals, by spreading, as they are known to do, from the immediate neighbourhood of the docks, constitute a perennial menace to all seaport towns, and, indeed, to the whole country, for the insects are frequently carried by rail for long distances in bales and packages. All those who know anything of the West Indian banana trade, for example, will be ready to bear out this statement, for numerous living insects and spiders are found hiding in the bunches of fruit.

THE "AUSTRALIAN" COCKROACH.

The Australian cockroach (*Periplaneta australasiæ*) is a near relation of *P. americana*, which it resembles, although it is somewhat smaller on the average. It is said to be numerous under glass at Kew, as well as in hothouses in various parts of the country; and there seems no reason why—given the opportunity—it should not spread to bakeries, factories, and even private houses, wherever the normal temperature was sufficiently high for its comfort. Outside Australia, it is thoroughly established as a pest in several parts of the world, notably Central America and the Southern States. It is, moreover, one of the common "ships' cockroaches."

The identification of the four species of cockroaches mentioned in the foregoing paragraphs is not difficult. The common Oriental form is dark mahogany brown in colour, without markings; the German cockroach is relatively small (about five-eighths of an inch

long), reddish in colour, with two dark, longitudinal marks on the pronotum—*i.e.*, the plate which covers that part of the body immediately succeeding the head; the American cockroach is a handsome, chestnut-brown species, one inch and a quarter or more in length; while its Australian cousin, besides being somewhat smaller, may be recognised by a clearly defined yellow band on the pronotum, and a narrow yellow spot on each fore-wing. The nature of the loss occasioned by the presence of cockroaches is well known. Anything and everything in the least degree edible is liable to be nibbled at and polluted; and the characteristic smell of the insects is so penetrating and unpleasant that a badly infested pantry or cupboard is soon rendered practically useless as a place of storage for food. It has been found almost impossible to eradicate the odour from empty bottles in which cockroaches have harboured for a few weeks or months.

THE HOUSE-CRICKET.

The common house-cricket (*Gryllus domesticus*) is not likely to be confused with a cockroach, if only for the reason that it bears some resemblance to a grasshopper, especially in the detail of its long hind-legs, which are formed for leaping. (Fig. 3.) The newly hatched young, however, are apt to puzzle the novice in domestic entomology, for they have been likened (not without reason) to pale-coloured fleas. There seems no reason to doubt that crickets are far less numerous in this country than was formerly the case; and some observers are of opinion that they are in process of extermination by the Oriental cockroach. This may very well prove to be the case, as the two insects agree pretty closely in habitat and habits, while the cockroach is unquestionably the more dominant. Also, it is a fact that crickets are rarely, if ever, found in association with cockroaches.* The "chirping" or "shrilling" sound for which the house-cricket is famous is produced (by the male insects only) when the fore-wings are rubbed together in such a manner that a file-like nervure which traverses the under-side of the wing is rubbed across a ridge-like projection on the wing below. The "song" thus produced has been invested by poets and others with sentimental associations; but in the dead of night, in a house where crickets are plentiful, the nerve-racked wooer of that fickle dame slumber is apt to find it anything but soothing. Like all other

* White, of Selborne, however, speaks of them as living together amicably in the same kitchen.

Orthoptera, the house-cricket undergoes an incomplete metamorphosis; but scarcely any facts are recorded concerning its life-history. Judging by the structure and length of the female's ovipositor, we may assume that the eggs are inserted into deep crevices. In buildings which harbour this insect, the young may be found in all stages of development at all seasons of the year; from which we may infer that breeding is not confined to any particular part of the year. The house-cricket is usually supposed to be a native of North Africa, where it is said still to exist permanently in the open, although Dr. Sharp appears to throw doubt upon this assertion, and seems to prefer the theory that these supposed wildings have merely left their quarters in dwelling-houses during the hot weather. Yet this insect has somehow managed to achieve a very wide distribution in the Old World, while it is also found in North America.

GILBERT WHITE ON THE HOUSE-CRICKET.

Relative to this question, Gilbert White has an interesting note in his forty-seventh letter to the Honourable Daines Barrington. "In the summer (he writes) we have observed them to fly when it became dusk out of the windows, and over the neighbouring roofs. This feat of activity accounts for the sudden manner in which they often leave their haunts, as it does for the method by which they come to houses where they were not known before. It is remarkable that many sorts of insects never seem to use their wings but when they have a mind to shift their quarters and settle new colonies. When in the air they move '*volatu undosu*,' in waves or curves, like wood-peckers, opening and shutting their wings at every stroke, and so are always rising or sinking." White also records the now well recognised partiality of crickets for moisture, and relates that they "often gnaw holes in wet woollen stockings and aprons that are hung to the fire." He says, too, that "when they increase to a great degree, as they did once in the house where I am now writing, they become noisome pests, flying into the candles, and dashing into people's faces. . . . In families at such times they are like Pharaoh's plague of frogs- 'in their bedchambers, and upon their beds, and in their ovens, and in their kneading troughs.'" These statements as to the objectionable nature of the cricket when it becomes a pest are amply born out by modern experiences, both in this country and in the United States, where the damage done by this insect to clothing, both linen and woollen, has occasioned special remark.

SUPPRESSING COCKROACHES AND CRICKETS.

The measures which may be adopted for the suppression of cockroaches will prove equally effective where crickets are concerned. If the insects have not become very numerous, surprisingly good results may be achieved with traps and powders; but the matter must be undertaken systematically, and followed up for a considerable period—for one whole summer season, at least. There are several useful traps upon the market, the best, perhaps, being those which employ the principle of a balanced platform that is tilted over by the weight of the insect as it attempts to get at the bait. Very effective traps may be readily contrived, however, from empty circular tin boxes—such as those in which coffee is packed. These are simply set on the floor, without their lids, and provided with inclined planes of cardboard or thin wood. The bottom of each tin is baited. Newly sliced onion is good for the purpose; but a fragment of almost any sort of food will serve; while if the tin is sufficiently "tight" to hold liquid, a little stale beer may be employed, and may be recommended on the score that the captured insects quickly drown in it. Deep tins that are perfectly bright and smooth inside must be selected, for any roughness of surface would enable the cockroaches to climb up and make good their escape. With regard to powder, any of the proprietary articles may be used if one can rely upon its insecticide properties. "Keatings" is good; but unfortunately the same cannot be said of all the widely advertised powders. Probably there is nothing to beat pyrethrum powder, if it can be obtained and used in really fresh condition; but it keeps badly, and should therefore be purchased only from reliable tradesmen and chemists. If the powder be moistened with water, it can be readily moulded into conical masses which, after thorough drying in an oven, may be lighted and allowed to smoulder until consumed. The fumes are neither explosive, nor are they poisonous to human beings; but they are very destructive to insect life. Of course, when any appartment or cupboard is fumigated, care must be taken to make it as "tight" as possible by stopping all cracks and openings; otherwise, really satisfactory results cannot be expected. When cockroaches have become very numerous and troublesome, fumigation with hydrocyanic acid gas is probably the best and quickest way of dealing with them. This gas is not inflammable or explosive, but it is a deadly poison, and cannot be recommended for use by anyone who is not an experienced operator. Some notes concerning its employment will be found upon a subsequent page.

Borax powder has recently been used against cockroaches in the

United States, with results that are claimed to be highly satisfactory, but it cannot be too strongly urged that whatever powder is used to exterminate cockroaches, crickets and other insects, the utmost thoroughness must be observed. Shelving and floors should be liberally dusted, especial attention being paid to corners, cracks and crevices. Boxes, matting and the loose edges of linoleum should be lifted, so that the powder may be sprinkled beneath; and it will be found wise to blow the powder as far as possible into cracks by means of bellows. All this should be done methodically, on several evenings in succession, and repeated at intervals as long as any signs of the pests appear. Finally, it may be worth while stating that, if circumstances permit, a tame hedgehog or two, kept in the kitchen department, is an excellent safeguard against cockroach infestation. There is a case on record in which a certain large London hotel was completely cleared of cockroaches in a short time by four hedgehogs, whereas a professional "beetle catcher" had for four years previously pocketed a fee of £52 per annum without achieving appreciable results.

BEETLES AS HOUSEHOLD PESTS.

We may now turn to a consideration of the "sheath-winged" insects, or beetles (Coleoptera) that occur more or less commonly as pests in stores and dwelling-houses. Unlike members of the order Orthoptera, all beetles undergo a complete metamorphosis, the life-cycle being divided into three strongly contrasted stages. The egg discloses a larva, which is very unlike its parents in form; and after a longer or shorter period devoted to feeding, there is an abrupt change to the pupal condition, during the continuance of which no food is taken. Finally, after a more or less protracted period of apparent inertia—during which, however, most of the creature's living substance is, as it were, dissolved and re-cast in fresh moulds—the skin of the pupa splits asunder, and discloses the perfect insect, capable of reproducing its kind. Thus, we have the four distinct stages—egg, larva, pupa and imago—which characterise the metamorphosis of all the more highly specialised insects. But we should note the fact that the larvæ of beetles vary greatly in different families. Some are extremely active, and well able to roam about in search of provender. Others are soft-skinned grubs, either quite legless, or with the legs so much reduced in size that they are of trifling service as aids to locomotion. This second category includes most of those larvæ whose habit it is to burrow slowly through the substance which forms their food, and thus embraces the majority of those which are pests in the household.

WOOD-BORING BEETLES.

We take first a group of beetles whose larvæ burrow in wood and other hard substances. They are members of the extensive family *Ptinidæ*, and the most familiar example is the so-called "furniture beetle" (*Anobium domesticum*). The small, whitish grubs of this insect form tunnels in dry timber and woodwork of various kinds, passing through their bodies the minute fragments which they rasp away with their jaws, and finding in this meagre fare sufficient nourishment for their growth and development. It is this insect that is most commonly responsible for the "worm-eaten" condition of our furniture; hence its popular name. Yet it is not the sole culprit in this matter, for the closely allied, but larger species, called *Xestobium tesselatum* is also a "furniture beetle," although it infests more especially the heavier kinds of woodwork, such as beams, the wood-panelling of rooms, and wooden mantelpieces. (Fig. 4.) Before now, the entire woodwork of a house has had to be replaced in consequence of this insect's depredations. Several years ago, it was found to have established itself in the unique roof-timbering of Westminster Hall, in consequence of which a serious investigation of the creature's manner of life was commenced by Professor H. Maxwell-Lefroy, with a view to discovering a means of checking its ravages. Recently, the timber has been sprayed with a special solution suggested by the Professor, as the outcome of his experiments; but time alone can show whether this will serve to exterminate the pest. An interesting fact concerning *Xestobium tesselatum* is that it produces the once mysterious tapping sounds known as the "death watch." The smaller *Anobium domesticum*, as well as certain other insects, also "tick" or "tap"; but the sounds for which they are responsible are less audible than those made by *Xestobium*, which has been seen by naturalists in the act of striking its head and jaws against hard wood—apparently with the object of making known its whereabouts to others of its kind. A third species of "furniture beetle," said to be especially partial to willow wood, is known as *Ptilinus pectinicornis*—its second, or specific, name having reference to the remarkable comb-like structure of the male's "horns" or antennæ.

DESTROYING "FURNITURE BEETLES."

All these wood-boring insects are peculiarly difficult to cope with, chiefly because they work out of sight, often some distance from the surface of the timber. Even the perfect beetles are seen comparatively seldom, for they seem rarely to leave the shelter of the

burrows, wherein one generation succeeds another, until all the available wood has been riddled through and through with tunnels, and is thus reduced to a state of crumbling rottenness. Yet from start to finish, the surface usually presents an appearance of soundness, save for a relatively small number of little round holes through which a few of the beetles, more adventurous than the majority of their fellows, have come forth into the open. It seems to be true that these insects work only in sap-wood. Thus, in theory, heart wood alone should be used in construction, although in practice such a rule could hardly be adhered to. Painting is commonly advocated as the best safeguard; and if other considerations render this possible, and the coat is scraped off and renewed before the paint has had time to perish, it will probably be found perfectly effective. In the case of hard-wood furniture, etc., frequent polishing with beeswax and turpentine will go far towards keeping the pest at bay. When one has to deal with an actual case of infestation, no better advice is available than that given some ten years ago (in the *Daily Telegraph*) by Sir E. Ray Lankester. "If (he wrote) the piece of furniture (or its pieces) can without injury be 'baked' in a hot chamber for twenty-four hours, at a temperature a little over that of boiling water, that is the easiest method of destroying the pest. Or, again, I would suggest placing the piece of furniture in a refrigerating chamber for a week or two. If neither of these methods can be used, the piece of furniture should be placed in a very hot room, and creosote or bisulphide of carbon or a solution of cyanide of potassium should be injected with a very fine-nosed syringe into the little circular holes of the burrows on the surface of the wood; then the piece of furniture must be at once exposed to the cold, which will cause the air to be drawn into the burrows and diffuse the volatile poison within. The 'worm holes' on the surface should, as soon as the piece of furniture is quite cold, be closed by melted paraffin. If the piece of furniture which it is desired to 'cure' will stand submersion in water for a few minutes, and is not larger than a cricket ball, it is, of course, easy, by first warming it through and then plunging it into water containing corrosive sublimate or other poison, fairly to impregnate the burrows, and make an end of the beetles and their grubs." It should be added that bisulphide of carbon and cyanide of potassium are both deadly poisons, demanding the strictest precautions in their use.

OTHER HARMFUL PTINIDÆ.

Several other small beetles of the family *Ptinidæ* often occur as pests in houses in this country. Unquestionably, the worst of these

is the "bread," "paste" or "biscuit" beetle, commonly called the "drug-store" beetle in the United States, and known to science as *Sitodrepa* (*Anobium*) *panicea*. (Fig. 5.) It is difficult to suggest any substance of animal or vegetable origin that this insect will not eat, and apparently thrive upon. It attacks stored beans, peas, grain and seeds of all kinds, flour and meal, chocolate, black and red pepper, and other condiments, including ginger and spices. Dr. Sharp has reared it, through several consecutive generations, on a diet of opium; and it has also been reported to do well on tablets of dried, compressed meat. It is also known in some quarters as the "boot beetle," on account of the extensive damage that it has done in the past to cargoes of exported boots and shoes—its prime object apparently being to feed on the paste used in fastening the linings and leather together. It is, moreover, chief among the so-called "weevils" that infest ships' biscuits, and figures prominently in connection with the "army biscuit enquiry" that was commenced a year or two before the outbreak of war. Finally, it is the true "book worm" of librarians, and in this respect has accomplished enormous damage. In one instance, in a public library, it is said that a larva of this insect perforated twenty-seven folio volumes in so straight a line that a string could be passed through the tunnel and the whole set of volumes lifted up at once by it.

"SPIDER BEETLES."

There appears to be room for doubt whether the culprit in this case was really *S. panicea*, or another beetle known as *Ptinus fur*, which is also a pest of books. This insect belongs to a section of the *Ptinidæ* known as "spider beetles," because of their spider-like aspect, due mainly to the globular form of the abdomen. In the male of *P. fur*, however, this character is wanting, the body being long and almost cylindrical; so that the novice would almost certainly regard it as a distinct species, after comparing it with the female, whose abdomen has the round, inflated appearance characteristic of "spider beetles" in general. Both sexes are reddish-brown in colour, with two indistinct bands of white hairs across the elytra, or wing-cases. Although it is not so common as *S. panicea*, *P. fur* is nevertheless a pest to be reckoned with, since it is capable of very serious damage. Its tastes are very varied, ranging from stored goods of many kinds, through furs and clothing, to stuffed animals and dried plants in museums.

Three other "spider beetles" are to be found in store-rooms, cupboards, etc., where they accomplish more or less damage. First

there is a yellowish brown species, covered with delicate silky hairs. Its scientific name is *Niptus hololeucus*. Secondly, there is *Mezium affine*, which is hairy only on the head and thorax, the chestnut-brown wing-cases having a highly polished appearance. Thirdly, there is the quaint *Gibbium scotias* (literally "the humped-backed creature of darkness"), whose shining crimson globe of a body has been aptly likened to a tiny drop of blood. These three insects and their larvæ feed on a variety of substances, but do not bore into wood. Sugar is said to be especially attractive to *Mezium*, which, however, has been bred in considerable numbers from so unlikely a source as an old opera-hat which had been laid aside for some time. Of *Gibbium*, Butler relates that a heap of its carcases "was discovered amongst a resinous substance in a vase obtained from a mummy at Thebes, but whether they were an original embalmment or a subsequent invasion was not very clear."

One other Ptinid beetle should be mentioned, viz., the "tobacco beetle" (*Lasioderma serricorne*). Although primarily a pest of tobacco in all its forms, it is often guilty of serious damage to dry goods of many kinds, and is, perhaps, only less to be dreaded than the "paste beetle," which it resembles in appearance. On one occasion, this insect and its larvæ were found feeding on the silk with which furniture was upholstered.

The "spider beetles," *S. panicea* and *L. serricorne* are all difficult pests to deal with when once they have become firmly established. Thus, it is wise to be constantly on one's guard against introducing them into one's house along with purchased goods. Herrick truly says that the simplest and safest way of dealing with a package of infested material is to return or destroy it, and buy new. "Care should be exercised either to confine the beetles and return all of them with the package, or be sure to destroy them all so that they do not escape into the house." If this plan of returning all infested material were commonly adopted, manufacturers and merchants would soon be forced to protect themselves by taking measures to rid their premises of the pests. Fumigation is the surest way of exterminating these beetles if they have once thoroughly established themselves. "Where they occur in a sack or barrel of meal or flour (writes Herrick), they will usually be found near the top. In this case, the top of the meal or flour may often be carefully removed and fed out to animals and all of the beetles and larvæ gotten rid of in this way. If the larvæ have found their way up and down the sides of the sack or barrel and have penetrated a pretty good portion of the material in this way, there is not much that can be done except to use it in feeding to

animals. It would be best, however, to kill the larvæ and beetles by fumigating the cereal with carbon bisulphide, to make sure that none of them escape to infest other household materials. This may be done by setting a teacup of the liquid on top of the flour in a tin dish and covering the barrel tightly. Allow it to stand for two or three days in order that the gas may have time to penetrate into the flour as far as possible. In the meantime, do not go near the barrel with a light of any kind, for the gas of carbon bisulphide is inflammable and explosive." It should be added that the vapour of this chemical is also poisonous to man, and should be inhaled as little as possible.

BACON BEETLES AND THEIR KINDRED.

We turn, now, to the "larder" or "bacon" beetle and its allies of the family *Dermestidæ*. The common "larder beetle" (black, with a broad yellowish-grey band across the basal half of the elytra) is *Dermestes lardarius*. It is the chief culprit in so far as the spoilation of bacon and hams is concerned; but there is a black species with a pale patch on each side of the thorax (*D. vulpinus*) that does much harm in other directions; while two or three more members of the genus "need watching," since they are all, in the larval state, devourers of skins, dried carcases, and the like. Butler speaks of them as "the jackals of the flesh flies, coming round when the maggots of the latter have finished up all the soft juicy parts of a fresh carcase, and clearing off the hard and dry remnants of the skin, tendons, ligaments, etc., which their predecessors have left untouched." The adult beetles are found normally out of doors; but in spring and early summer they—especially the two species named above—are apt to enter buildings in search of material upon which to deposit their eggs. Breeding takes place among various food products, horn, hoofs, skins, beeswax, feathers and hair. The writer once found *D lardarius* established in a sack of dog-biscuits. The larvæ in this family are almost always clothed with stiff hairs, which are often arranged in a complex manner. They have well developed legs, and are much more active than is usually the case with larvæ that live in close contact with the substance on which they feed. As a rule, the pupal stage is passed through under cover of the last larval skin, which splits down the back, but continues to enwrap the pupa—serving, in fact, as a sort of protective jacket.

Closely allied to the "larder beetle" and its nearest relative is *Attagenus pellio*, also known as *A. piceus*. It is a smallish, black

insect, with a white spot nearly in the centre of each elytron, and three others on the posterior margin of the thoracic plate. In the main, it figures as a destroyer of skins, hair, and feathers; but, as Herrick remarks, it is a pest with "a varied menu and consequently one that is apt to be found committing a different kind of injury in different surroundings." In the United States, it is known as the "black carpet beetle," because it has been observed to play a part in the destruction of carpets and similar fabrics. The chief culprit in this respect, however, is the so-called "buffalo bug," or "buffalo moth"—really a little beetle known as *Anthrenus scrophulariæ*; but this remark applies only to America, for the insect is a rarity with us, and cannot be numbered among our domestic pests. Yet we should certainly be on our guard against it, for it is just the kind of creature that might be expected to gain a footing unperceived, and to cause endless trouble before it could be got under. At least five species of *Anthrenus* occur in Britain, and of these the notorious "museum beetle" (*A. museorum*) is one. This insect is widely known and dreaded on account of the injury which it does to natural history collections; but it also ranks prominently among household pests, and is especially liable to infest skins and furs. In the adult state, members of the genus *Anthrenus* (which is included in the family *Dermestidæ*) frequent flowers in the open, and enter buildings in search of such materials as afford food for the larvæ. Thus, the beetles which have recently accomplished their metamorphosis may often be found upon the panes of windows, inside, evidently trying to effect their escape from the building.

"BACON BEETLES."

Mention must be made here of two small, flattish, shining blue-black beetles called *Corynetes cæruleus* and *Necrobia rufipes.* They are not nearly related to the "larder beetle," but are often found in its company and are recognised feeders on skins, dried meats, etc. In the United States, the *Necrobia* has done much damage to hams and bacon. Herrick says that the larvæ "burrow into the outside layers of fat just beneath the rind and grow rapidly, for they are ravenous eaters." If these pests, and the *Dermestidæ,* are to be kept at bay, very careful attention should be given to the wrapping of meat as soon as possible after the process of curing is complete. "The wrapping cannot be made too tight (writes Herrick), for the least opening or crack will allow the entrance of the beetle to deposit its eggs. If a ham or similar article of food should become infested with the grubs, the part containing them should be cut

away and destroyed by burning or otherwise, and the remaining part of the meat treated with a dilute solution of carbolic acid." The same writer suggests that much good may be done by exposing pieces of cheese, of which the *Dermestes* beetles are very fond, and upon which they will congregate. The baits must be examined at short intervals, and the beetles destroyed. Similar lines might probably be followed, with advantage, in dealing with the smaller skin and fur pests when the beetles are known to come in from the open for the purpose of egg-laying—the traps being set during the spring and early summer, when breeding is in progress. When a store-room or cupboard is found to be badly infested, it should be thoroughly cleaned, and finally sprayed with benzine, or fumigated with hyrocyanic acid gas. Rugs, carpets, articles of clothing, etc., should be treated with benzine (which is highly inflammable), or fumigated.

GRAIN AND MEAL BEETLES.

We may now consider those beetles which are found especially in bins, granaries, mills, etc., where they occasion loss by destroying meal and grain. Several of these pests belong to that section of the Coleopterous order which is known as Heteromera (literally "different joints"), because the number of joints in the tarsi, or feet, is not the same in all the three pairs of legs: in the front and middle pairs of legs it is five, and in the hind pair four. One of the largest, and perhaps the most widely known, British species is *Blaps mucronata*, often called the "cellar" or "churchyard" beetle, because it is apt to occur in these localities. Its larva feeds on waste matter of various kinds, and resembles a large meal-worm in appearance—the two being, in fact, not distantly related. So far as the writer is aware, *Blaps* scarcely falls within the significance of the word pest, in its ordinary acceptation; but, since it is associated with damp and dirty surroundings, and has a disgusting effluvia, resembling that of putrid flesh, it may fairly be written down a nuisance. Strict attention to cleanliness, and the application of insecticide powder, will suffice to expel it, and keep it away.

MEALWORMS.

True "meal-worms" are of two sorts. They may develop, according to their species, either into the beetle known as *Tenebrio molitor*, or into that called *T. obscurus*. Both these insects are lightish brown soon after they have cast aside the pupal skin; but

when their integuments have become thoroughly hardened, they appear black, with this difference, that the former is polished and shining, while the latter is dull and opaque. In his little work published in 1866,* E. C. Rye makes the interesting statement that "meal-worms obtained from the east end of London usually produce *T. obscurus;* whilst those from the west end produce *T. molitor.*" Whether this is still true the present writer is unable to say. But meal-worms appear to be far less numerous and destructive than was formerly the case—probably because systematic measures for their suppression are now widely adopted. It may not be generally known that there is a recognised "trade" in living meal-worms for the use of fishermen and the feeding of captive birds and small animals. The chief centres from which supplies were drawn were situated in Germany; and at the outbreak of war consumers knew not where to turn. It is an open secret that the officials of the London Zoological Society were almost at their wit's end for a time, until they began to breed meal-worms on their own account. In this way the hiatus has been filled. Yet it is admitted, not without regret, that British meal-worms are distinctly inferior to those of Teutonic origin.

Meal-worms have spread with commerce into almost every part of the world. They live continuously among their food, and multiply rapidly, although normally there appears to be but one generation in the year. The eggs are laid among the meal. The two species of larvæ resemble one another in general appearance, but *T. molitor* (sometimes called "the yellow meal-worm") is lighter in colour than *T. obscurus*, The period of feeding may continue for three months, or longer, while the pupal stage is said to last about two weeks.

OTHER CORN AND MEAL BEETLES.

Still keeping to the Heteromera, we come to two small beetles, almost indistinguishable by the novice, known as *Tribolium confusum* and *T. castaneum* (*ferrugineum* of some authors). They are about one-eighth of an inch in length, dark reddish-brown in colour, and are known as "flour beetles" in some quarters. Their slight points of difference, microscopic in character, are too technical to be dealt with here. The larvæ resemble miniature yellow meal-worms. Although they are often referred to as exclusive flour

* "British Beetles." E. C. Rye. Lovell, Reeve & Co. 1866.

pests, these insects are in reality very general feeders, for, in addition to cereals and meals, they are known to breed in a great variety of substances, of which baking powder, cayenne pepper and snuff are three of the more remarkable.

Another little Heteromerous beetle, which often occurs in bakeries, etc., where it and its larvæ feed on flour, meal and grain, is *Gnathocerus cornutus*—mentioned by Curtis as "*Uloma cornuta*—the horned maize-beetle." It is said to be a native of Portugal, whence it has been imported with corn.

Another beetle that frequents granaries, mills, storehouses, etc., is *Tenebroides* (*Trogosita*) *mauritanica*. Although it bears a superficial resemblance to a small *Tenebrio*, it belongs actually to a perfectly distinct family (*Trogositidæ*), which is not even included in the Heteromerous section of Coleoptera. This insect is often called the "Cadelle," a name which was first applied to it in France. It occupies a somewhat anomalous position, for while it undoubtedly feeds on grains and other food stuffs, it is known also to prey upon the larvæ of other pests (such as the *Tribolium castaneum* previously referred to)—a fact that was first observed by Miss Ormerod, and has more recently been confirmed in connection with the "army biscuit enquiry" conducted by Durrant and Beveridge.* It is noteworthy that the full-fed larva usually burrows into woodwork before changing to the pupa; and this is a bad habit, judged from the economic standpoint, because its old borings serve as hiding places for other pests.

The little saw-toothed beetle (*Silvanus surinamensis*), which gets its popular name from the fact that each lateral margin of its thoracic plate bears conspicuous, tooth-like projections, has been found among a variety of dry goods, but is more especially a pest of stored grains. It is about one-tenth of an inch long, flattened, and reddish-brown in colour. It belongs to the family *Cucujidæ*, which also includes *Læmophlœus ferrugineus*—described as a corn pest by Curtis† under the name *Cucujus testaceous*. This is a smaller beetle than the *Silvanus*, and there is another smaller yet, called *Læmophlœus minutus*. No modern records of injury by these two *Læmophlœi* appear to exist; but as they seem commonly to occur with the infinitely more harmful grain weevils, the comparatively small amount of injury which they do must often be overlooked, or charged to the account of their larger companions.

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* "Journal Royal Army Medical Corps," XX. (pp. 615–634). London. June, 1913.

† "Farm Insects." John Curtis. John Van Voorst. 1883 (p. 330).

As these grain weevils (*Calandra granaria* and *C. oryzæ*) were dealt with by the writer in the last issue of the *Journal*,* they may be passed over here without further remark.

CONTROLLING GRAIN AND MEAL BEETLES.

With regard to the control of these grain and meal infesting beetles, the most practical remedy is fumigation with carbon bisulphide. After this has been done, constant watchfulness, and strict attention to cleanliness, will go far to prevent a recurrence of the pests. Especial care should be taken to guard, as far as possible, against the introduction to the premises of infested material. This completes the list of beetles that are most likely to occur as pests in our stores and dwelling-houses.

HARMFUL MOTHS OF THE HOUSE.

We turn now to a group of very different insects, viz., moths. These belong to the " scale- winged " order, or Lepidoptera, which is so called because the wings of these insects are clothed normally with minute flattened hairs of a peculiar type, not unlike—but, of course, infinitely smaller than—the scales of a fish in appearance. Lepidoptera undergo a metamorphosis which is even more complete than that of the average beetle, the pupa being " obtected "—*i.e.*, covered by a general hardening and thickening of the outer crust, and totally unlike the perfect insect that is to be; whereas, in the pupa of a beetle, the appendages of the imago, or adult, are easily recognisable. Furthermore, the larva of a moth is a caterpillar. In other words, it has a soft, worm-like body with short, stumpy " prolegs " on certain of its hinder segments in addition to the three pairs of " true legs " which belong to the three segments immediately succeeding the head. Nearly all caterpillars spin cocoons before they change to pupæ, and when so doing they frequently make use of fragments of the material among which they have been living, matting these together with the silk thread that issues from the " spinneret "—an organ situated just below and behind the mouth. The great majority of caterpillars feed on living plants ; but a few subsist on dried vegetable products, or (more rarely still) on substances of animal origin. It is among these exceptional forms that we find our store-house and domestic pests.

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* "Journal of the Bath and West and Southern Counties Society." Fifth Series. Vol. XI. (1916–1917). pp. 70–1.

The reader should be reminded here that the adult moths do no direct harm. They are only to be dreaded because they are the potential parents of caterpillars; for the parts of their mouths are either so little developed as to be functionless, or, if developed, are of a type fitted solely for absorbing liquids by suction. Hence, when damage is mentioned in succeeding paragraphs, it must always be laid to the charge of the caterpillars—not the moths.

MOTHS OF THE FAMILY *Pyralidæ*.

All the moths that we could wish for economic reasons to exclude from our stores and dwellings, belong to one or the other of two great families, viz., the *Pyralidæ* and the *Tineidæ*. Among the *Pyralidæ* we find two or three species that are very destructive to flour and meal, and several that infest dry goods, such as figs, currants, chocolate, biscuits, etc. The "meal-moth" or "meal snout-moth" (*Pyralis farinalis*) is often seen in houses, resting upon walls or ceilings. It has a wing expanse of about four-fifths of an inch, and is apt to attract attention on account of its striking coloration. The fore-wings are purple-brown, crossed by a broad, ochreous band edged with curved white lines, which are continued (so to say) over the uniformly grey surface of the hind-wings. The caterpillars live in silken galleries, or tubes, which they spin among the substances on which they feed. These include flour, meal and bran, as well as straw, husks, corn-refuse, and seeds, whole or ground. Another equally common household insect is the "tabby" (*Aglossa pinguinalis*), which has greyish-brown fore-wings traversed by many dark lines—like a tabby cat! There is a persistent tradition that the caterpillars feed on fatty substances, such as butter; but this seems to be quite without foundation in fact. Indeed, this species probably does little real harm, since it feeds among chaff and hay-refuse, such as is found in lofts and stables. As in the case of *P. farinalis*, the caterpillars spin tubular galleries among their food.

THE GENUS *Ephestia*.

Still keeping to the family *Pyralidæ*, we come to the genus *Ephestia* of which most of the species, when larvæ, infest dried groceries and the like goods, while at least one (*E. calidella*) stands convicted of feeding on cork. This species is also known as *E. ficella*, and is one of the pests of dried figs. The most notorious member of the genus, however, is the so-called "Mediterranean flour-moth" (*E. kühniella*), whose larvæ feed on flour. This insect was practically unknown until

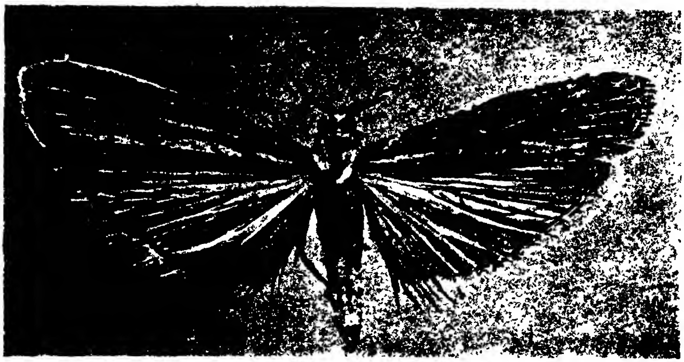


Fig. 6.

Fig. 7.

Figs. 6, 7 and 8.—Moth, caterpillar and cocoons of *Ephestia Kühniella* (much enlarged).

Fig. 9.—Pearl-barley the grains fixed together by larvæ of *Tinea gravella* which are feeding within.

Fig. 10.—Case formed by larvæ of the Case-making Clothes Moth (enlarged).

some thirty-seven years ago, when it was discovered in a flour mill in Germany. It invaded England in 1886, appeared in destructive numbers in Canada in 1889, and was found in mills in California three years later. In 1895 it was reported present in New York and Pennsylvania, and during subsequent years it has spread over a large part of the United States. It is a great scourge when it gets into mills, not only on account of the loss which it imposes, but because the caterpillars clog the rollers and block up the machinery by matting the flour and meal together with silk. The caterpillar is pinkish-white in colour. It prefers flour, meal or bran, but will attack grain and most cereals. When full-fed, it spins a cocoon, which it usually fastens to some surface. In favourable circumstances, the life-cycle is accomplished in two months, or less, and breeding continues without intermission throughout the whole year. (Figs. 6, 7 and 8.) Closely allied to *E. kühniella* is the so-called "Indian meal-moth" (*Plodia interpunctella*), which in this country usually breeds among maize, figs, seeds, etc., but (as Holland, the distinguished American entomologist remarks) "has a propensity to feed upon almost anything edible that comes its way." Roughly speaking, all the little moths referred to in this paragraph have greyish or fuscous fore-wings, and pale hind-wings. The wing expanse varies in the different species from ½ in. to ⅞ in., *E. kühniella* being, on the average, slightly larger than the others.

WAX MOTHS.

Before quitting the *Pyralidæ*, mention must be made of the wax-moths, which may really be ranked as household pests, since the larvæ are often very destructive to stored wax, and tend (as the present writer believes) to cause injury in other directions. The chief "wax moth" of the bee-keeper is *Galleria mellonella*. The caterpillars burrow in the comb or in stored wax, and line their galleries with silk, eventually spinning tough cocoons before changing to pupæ. A smaller species known as *Meliphora* (*Achroia*) *grisella* is often very destructive in old hives, and to stored wax, while it has been found feeding among dried apples, and is probably capable of becoming much more generally harmful than is at present suspected. A third species (*Aphomia colonella*) is usually associated with wasps and humble-bees, but it sometimes occurs in bee-hives. It is a noteworthy fact that its larvæ have the habit of leaving the hive before they spin their cocoons. As a safeguard against these pests, wax and similar materials should be carefully stored with

naphthaline in a tightly closed box or cupboard, in which sulphur may, with advantage, be burnt from time to time. The most effective remedy against wax moths, however, is said to be the compound known as "apicure," the invention of Mr. Herrod-Hempsall, the well-known expert in apiculture.

THE WINE-CORK MOTH.

It has been stated above that certain of the *Ephestia* larvæ sometimes feed on cork. The real "cork-moth," or "wine cork-moth," however, is a member of the family *Tineidæ*. It is a tiny insect with fuscous wings which frequents cellars, where the larvæ appear to feed normally on fungi growing on the walls—spinning silken galleries as they move from one spot to another. But the moth also lays its eggs upon the corks of wine bottles; and then the caterpillars are apt to burrow into the corks, and cause mischief. The presence of the wine-cork pest is manifested in an accumulation of cork dust and refuse ("frass") round the exposed portion of the cork. Later, if the larvæ are numerous, the cork may be so much tunnelled that the wine escapes—this being the so-called "ullage" of wine. Sherry, Madeira and Champagne corks are attacked indiscriminately; and even when the corks are not so badly tunnelled as to cause ullage, the wine commonly becomes tainted, and is thus rendered valueless. Strict attention to cleanliness, and periodic white-washing, should result in expelling and keeping away this pest from wine-cellars where it may be troublesome. The protection of the corks—by a thorough application of sealing-wax, wrappings, or in some other manner—so that the moths and caterpillars may be unable to get at them, is also an obvious remedy.

THE FAMILY *Tineidæ*.

In addition to the wine-cork moth mentioned above, the family *Tineidæ* includes two notorious grain pests, viz., the Angoumois moth (*Sitotroga cerealella*),* and the "little grain moth" (*Tinea granella*). The former got its popular name from the fact that the scene of one of its early outbreaks (about 1750) was Angoumois, in France. Strictly speaking, these insects are granary pests, and are terribly destructive to stored grains; but they are sometimes found in houses. The imago of *Sitotroga* "in appearance

* Called *Butalis cerealella* by Curtis, in his "Farm Insects."

much resembles a fragment of chaff" as Meyrick remarks; that of the *Tinea* has cream-white fore-wings which are much mottled and spotted with rich brown, while the hind-wings are grey. In both instances the caterpillars are white, with brown heads. That of *Sitotroga* appears usually to feed in a single grain, which provides sufficient nutriment for the completion of its metamorphosis; but the larva of the *Tinea* has the habit of burrowing from one grain into another, fixing the two together. (Fig. 9). In this way it often unites a number of grains ere it changes to the pupa. Both these moths are known to deposit their eggs on grain in the open—even before the ears are perfectly matured—as well as on that which has been garnered and stored. This habit renders these pests peculiarly difficult to deal with, as precautions of cleanliness in mills, granaries, etc., will not suffice to keep them at bay, since the eggs are liable to be introduced anew each season along with the grain. Periodic fumigation appears to be our only safeguard.

CLOTHES MOTHS.

Belonging to the family *Tineidæ* are several small moths whose caterpillars destroy woollen and other fabrics, feathers, fur, etc. These are known popularly as "clothes-moths." Three kinds are especially common. The case-making clothes-moth (*Tinea pellionella*), which is perhaps the commonest of all, appears first in February, and may continue in successive broods until November, after which no more moths are seen, although the insects may be found in other stages of development in the infested material. It has yellowish fore-wings, with three distinct dark spots on each. The caterpillars construct tubular cases from particles of wool, etc., and live in these shelters, dragging them about with them much as a snail drags its shell. (Fig. 10.) In these cases, too, they eventually change to pupæ. The webbing clothes-moth (*Tineola biselliella*) resembles *T. pellionella* in colouring, but has no dark spots on the fore-wings. Moreover, its caterpillars do not form cases, but spin a silken webbing as they wander over the food material. When full-fed, they spin together fragments of wool or hair to form a cocoon. The tapestry moth (*Tricophaga* (*Tinea*) *tapetiella*) has wings which are dark from base to middle, then white clouded with grey to the outer margin. It is also considerably larger than the two other species. The caterpillars form galleries of silk in the materials that they attack, which are usually furs, or thick woollen stuffs, such as felt, carpets, horse blankets and the upholstering of carriages.

Dealing with Clothes-Moths.

Frequent beating and shaking in the open air, especially on sunny days, will do much to preserve clothing and fabrics from the attacks of these pests. Napthaline or camphor may be placed in boxes and cupboards where such things are stored; but while their vapours may do some good by keeping off the adult moths, they do not kill the insects or their larvæ, which must be destroyed by fumigation, or by spraying with benzine. Benzine will not stain or affect the colour of fabrics; but it is very inflammable, and should never be used in a room where there is a fire, or where lights (other than electric) are burning. An excellent method (suggested by Howard) of storing clothing that will not be needed for a period of months is to place the garments in well made cardboard boxes, and then paste strips of paper round the edges of the cover, and over any cracks. If the goods are thoroughly sprayed with benzine before this is done—or even shaken and brushed thoroughly with a view to ridding them of any eggs which may be present—they are not likely to suffer injury. Valuable furs, and large quantities of clothing, are best stored in a refrigerating chamber, a temperature of 40°F. being protective, since it has been proved sufficient to maintain the pests in an inactive, dormant condition, and would doubtless destroy them in process of time.

Three Other Destructive Moths.

Three other members of the family *Tineidæ* call for mention. First, there is the moth known to science as *Monopis* (*Tinea*) *rusticella*. It has dark fore-wings, speckled with a lighter tint, and with a small transparent spot in the middle of each. It is a "clothes moth" in the sense that the larvæ often feeds on woollen goods; but it is by no means particular in the matter of its diet, and will breed freely in almost any kind of dry animal matter. Secondly, there is the species that is sometimes called the "window-moth" (*Endrosis lacteella* [*fenestrella*]), which seems to have a peculiar knack of getting drowned in milk jugs and pans, and hence is known in some quarters by the second nick-name "milk-moth." It has dark mottled fore-wings, but its head and thorax are brilliantly white. Its caterpillars feed on dry refuse, especially of a vegetable nature, seeds, etc., but they are not known to injure clothing. Thirdly, there is *Acompsia* (*Œcophora*) *pseudospratella*, which Butler has truly described as "one of the most destructive insects imaginable," because "nothing in the smallest degree edible comes amiss to" its caterpillars. Only this season the present writer found a thriving

colony of this moth in a hay-box (used for cooking) that had been left idle for several months. The larvæ appeared to be feeding both on the hay and on the thick felt with which the box was lined, not to mention the paper that had been used for padding; while the very wood of the box itself had evidently been rasped away in places. The moth has pale brown fore-wings, much mottled with a darker tint, and with three very distinct brown spots on each—two before the middle of the wing, placed one above the other like a colon (:), and one beyond the middle, like a period, or full stop. The hind-wings are whitish grey, darker posteriorly. Like most pests of this nature, this insect can be controlled most effectively by fumigation.

THE HOUSE ANT.

We have now dealt with most of the insects that may be regarded as domestic pests in this country. To complete the list however, we must include three or four other species. One of these is the tiny ant *Monomorium pharaonis*, known in certain quarters as the "house ant," and in the United States as the "red ant," although its colour is really yellow, or honey colour. It is one of the smallest ants known, being only about one-sixteenth of an inch long; but it seems to make up for this deficiency in individual bulk by its extraordinary powers of increase. When it has once firmly established itself, it literally swarms in houses, and is discovered by the hundred—even by the thousand—in every receptacle where food is stored. It has a special liking for sugar and sweet substances; but nothing edible comes amiss to it; while there seems to be no doubt that it wages war against bed-bugs and the smaller cockroaches—a number of the ants attacking simultaneously, and by sheer fierceness and persistency overcoming the resistance of their giant victim. Unfortunately, *Monomorium* is a hunter only by fits and starts, and one may question whether it would ever turn its attention to vermin so long as it had easy access to sugary and starchy foods; so that its presence in the house cannot be tolerated.

Like so many other household pests, *Monomorium* is not indigenous, nor is it universally distributed in this country. It seems to be most common in London and the south-eastern area, but it is by no means confined thereto, and must frequently be carried about with goods of various kinds. When in this way a "queen" ant is introduced into a building where the normal temperature is sufficiently genial, there is serious risk that a nest will be formed and a colony established. The tiny "workers" do not signify in a case of this sort, for although they are the chief mischief-makers,

they are incapable of reproduction, and do not live very long. But the queen—she is darker in colour than the workers, five times as bulky, and quite two and a half times as long—is a mother of almost incredible fecundity. Once let her establish herself comfortably and she will go on laying eggs until her family may come to number hundreds of thousands. At first the queen is both mother and nurse; but later, as the colony prospers, the care of the rising generation devolves upon the workers that have already become adult, and the queen devotes her whole energies to egg-production. Ants undergo a complete metamorphosis, and the larvæ, or grubs, are fed and tended by the workers with the utmost care.

Food may be kept free from ants by supporting it, by means of a trivet, above a dish of water, the surface of which may, for greater security, be covered with a film of oil. Ants may also be trapped in various ways—as, for example, by means of small sponges saturated with sweetened water. The insects congregate in the pores of the sponges, which should be thrown into boiling water at least once every day. In this way large numbers of the pests may be got rid of; but the only method by which the premises may be permanently freed is to discover the nest, and destroy it, together with the queen, or queens—for it seems certain that several of these royalties often dwell amicably together in the same abode. The nest may be looked for behind woodwork, under the floors, in old trunks or boxes, among dry refuse stacked in lumber-rooms, or in the walls of the house; but it is often difficult to locate and to deal with satisfactorily when found. Some help may be derived from observing the direction taken by the streams of home-going ants, among which many individuals will probably be carrying atoms of food. In most instances, the nest can be best treated with carbon bisulphide; but the advice and assistance of an expert is desirable when this dangerous chemical is employed.

THE "SILVER-FISH" OR "SILVER-LADY."

Most housewives know by sight the little "silver-fish" or "silver-lady"—the *Lepisma saccharina* of science. If frequents pantries and cupboards, and is also found among books and papers. It is believed to feed chiefly on starchy and sugary substances; but there is some evidence to support the view that it will also eat matter of animal origin when its favourite foods are not forthcoming. Be this as it may, *Lepisma* certainly does damage in libraries by gnawing away the surface of paper and attacking the bindings of books; while it has also been convicted of injury to wall-paper, laundered

clothing, etc. A very similar species of insect, which is especially common in certain warehouses and bakeries in London, is *Thermobia furnorum*—also known as *Lepisma domestica.* It is called locally the " baker's brat," or " fire brat," and loves warm and dry situations where sugary food is obtainable. Both *Lepisma* and *Thermobia* belong to an order (*Aptera*) of very lowly insects. They never develop wings, and undergo no metamorphosis—the newly hatched young exactly resembling the adults, except in size.

THE " BOOK-LOUSE."

In company with *Lepisma,* we may frequently observe a much smaller creature, viz., *Atropos divinatoria*—the so-called " book-louse." Although exceedingly minute, it is known to be an enemy to books and manuscripts. It also feeds on a variety of farinaceous substances, and is terribly destructive when it gets among collections of natural history objects, such as dried plants and insects. Its nearest relatives in the animal kingdom appear to be the " biting lice " which live among the feathers of birds, and the hair of a few beasts; but besides *Atropos* there are two or three closely allied forms, all of which—when they are found in dwellings—are lumped together under the name " book-lice." Dry straw seems to be a favourite haunt and breeding-place with *Atropos;* and it has been observed to emanate in prodigious numbers from straw mattresses. Thus, as Herrick remarks, straw should be carefully examined before it is used for any household purpose, and if any " book-lice " are observed, it should be discarded, and a fresh supply obtained. Despite its diminutive size, this insect shares with the beetles, previously mentioned in this article, the title of " death-watch," because it is supposed to produce a regular tapping noise by knocking its jaws or head against woodwork. Whether this is indeed the case remains an open question, although several competent observers attest it as a fact. " Book-lice " and " silver-fishes " may usually be kept under by the use of powder, such as pyrethrum; but if they should become excessively numerous and prove difficult to exterminate, fumigation of the premises will be found effective.

FLIES AND WASPS.

Numerous flies occur as pests in our houses and stores; and the so-called flesh-flies, in particular, are the cause of considerable loss. For information concerning these insects, the reader is

referred to a recent article by the present writer.* Wasps are another source of loss and annoyance. They can only be held in check effectually by destroying their nests in the open. The subterranean nests are best dealt with by pouring a good quantity of carbon bisulphide into the opening, which should then be covered immediately with sods, well rammed home. This, of course, should be done after dusk, when the wasps have retired for the night; but it is wise to act before darkness has set in, so that the work may be accomplished without a lamp, since carbon bisulphide is highly inflammable and explosive. A good way to destroy the nests of wasps that build in trees and bushes is the following. First plug the entrance, after dark, with cotton-wool. Then saturate the nest with paraffin; and finally set a light to it.

FUMIGATION.

Before concluding this article, a few particulars concerning the use of fumigants may be given; but in all cases where this method of exterminating pests is resorted to, the novice is strongly urged to avail himself of the advice and assistance of an expert. Whenever a house, room, cupboard, box or bin is to be fumigated, it must first be made as nearly air-tight as possible by stopping up all cracks and crevices. The fumes will so quickly escape through holes and cracks if these are left open that their effectiveness will be greatly lessened. Herrick points out that strips of newspaper two or three inches wide, that have been thoroughly wetted, may be applied quickly over the cracks round window sashes and elsewhere, and that they will continue to adhere for several hours. In doubtful cases, however, it will be wise to paste the strips in position. The fumigants most commonly used are hydrocyanic acid gas, carbon bisulphide, and sulphur dioxide - *i.e.*, the fumes of burning sulphur.

HYDROCYANIC ACID GAS.

Hydrocyanic acid gas has been much used of recent years for fumigating granaries, factories, mills, dwellings and greenhouses. The gas is fatal to all kinds of pests, and Theobald states that in most cases the eggs are also destroyed. It is not inflammable or explosive, nor does it bleach the colours of wall papers, draperies, or other household fabrics. It does not attack metals, or gilt on

* "Journal of the Bath and West and Southern Counties Society." Fifth series. Vol. IX. (1915–1916). pp. 33–52.

picture frames, etc., with this exception, that it will slightly tarnish nickel fittings. The tarnish, however, may be rubbed off easily with a cloth. The gas does not harm dry food substances, like flour, bread, biscuits, etc.; but moist or wet foods, like butter, milk and cream, are apt to absorb some of the gas, and should therefore be removed before fumigation.

Full instructions for fumigation with hydrocyanic acid gas are issued by the Board of Agriculture and Fisheries (see their leaflet No. 188). They should be carefully studied before the treatment is resorted to, since the materials used include cyanide of potassium — a most deadly poison. The proportions of the chemicals do not vary, but the quantities per cubic foot of space must be determined by the special needs of the case. The usual formula for treating 100 cubic feet of space is as follows:—

Potassium Cyanide (98 p. c.) ...	1 oz.
Sulphuric Acid (sp. gr. 184) ...	1 oz.
Water	3 or 4 ozs.

The sulphuric acid should be added to the water in a very slow stream, or better still, drop by drop. As the mixture at once becomes boiling hot, it should be prepared in a strong earthenware vessel. The diluted acid will destroy clothing if dropped thereon, but is not otherwise very corrosive. To generate the gas, the cyanide is dropped into the diluted acid; but as the deadly fumes begin to rise immediately, this operation is best performed from outside the room or building. This may be done with a long stick used through a window, or by means of a string or pulley; but specially constructed, cheap apparatus may be bought for the purpose. Fumigation should continue for about an hour; after which the interior must be thoroughly ventilated—the windows, etc., being opened from the *outside*, and the operator taking care not to inhale any of the escaping fumes. Several hours will probably be necessary to allow for the dissipation of the gas, which has a characteristic smell like peach kernels, easily recognised. No room should be occupied until this odour has completely passed off.

It is worth noting that Theobald and Strawson recommend the use of sodium cyanide in preference to potassium cyanide, because in its re-action with sulphuric acid this chemical yields a much greater volume of hydrocyanic acid gas. Thus, in the formula given above, the 1 oz. of potassium cyanide might be replaced by two-thirds of an ounce of sodium cyanide.

The following passage, by Herrick, cannot be too strongly recommended to the reader's attention. "The greatest care must always

be exercised in fumigating houses and rooms that are being occupied. Before fumigation a house should be vacated. There may be danger in fumigating one house in a solid row of houses, if it should happen that there was a crack in the walls through which the gas might find its way. It also follows that the fumigation of one room in a house might endanger the occupants of an adjoining room, if the walls between the two rooms were not perfectly tight. It is absolutely essential to keep these points in mind and to do the work deliberately and thoughtfully."

CARBON BISULPHIDE.

The vapour of carbon bisulphide is most frequently used to fumigate bins, cupboards, small rooms, or boxes into which infested materials have been specially placed for treatment. The pure chemical (a colourless liquid, one-fourth heavier than water) will not stain or injure the finest fabrics; but the commercial product, owing to the impurities which it contains, is apt to leave a slight stain after it has evaporated. Generally speaking, carbon bisulphide does not injure foodstuffs; but it has been shown experimentally (by Harcourt) to affect the baking qualities of flour—the loaves being "smaller, darker in colour, and poorer in texture and in general appearance," even after an interval of several months. Still, the flour showed a tendency to recover; and probably all effects of the vapour would disappear in process of time. The vapour of carbon bisulphide is heavier than air, and settles rapidly downward. It is highly inflammable and explosive, and must on no account be brought near to fire in any form. It is not harmful when breathed in small quantities by human beings, but prolonged inhalation deadens the senses, produces giddiness, and would eventually cause death. Two or three pounds of carbon bisulphide should be used for each one thousand cubic feet of space; and fumigation should extend over a period of at least forty-eight hours, the best results being gained when the temperature is between 65° and 75° F.

SULPHUR DIOXIDE.

Sulphur dioxide is produced by burning flowers of sulphur or lump sulphur, or prepared sulphur candles are sold for the purpose. About 2 lbs. weight of the chemical should be burnt for every 1,000 cubic feet of space. There are, however, certain objections to the use of sulphur. Unless the room and its contents are very dry,

papers and fabrics will be more or less bleached, and metals tarnished, owing to the formation of sulphuric acid. The gas has also been shown to affect the baking qualities of wheat flour at least, and presumably those of other flours; while when used in sufficient strength to kill insects in grain, the germinating power of the seeds is also destroyed. If used, sulphur should be placed in an iron pot supported by means of bricks in a large tub or pan of water, as a precaution against fire if the chemical should boil over, as it is apt to do. Sulphur is easily ignited by sprinkling a little alcohol over it before applying a match.

V.—RURAL HOUSING.

By Sir C. T. Dyke Acland, Bart.

For at least a century there has probably been no time when the question of rural housing was of such immediate and urgent importance as it is at present.

And this for two reasons, both connected with the war: (1) Because when peace is signed, and the Army begins to be disbanded, many men will be returning to the parish in which their home lies, in the hope of getting both residence and employment there. They will, however, in many cases find the cottage they left occupied by new comers, for whom, on account of the urgency of agricultural needs, it became necessary to find residences, which, however, could not at the time be supplied, mainly on account of the shortage of labour for building. (2) Because the great alteration in the status of agriculture in the public mind, and its recognition and consequent encouragement as an industry of real national importance (not only now but in future generations) must of necessity require the employment of at least as much labour as was necessary in the 1860—80 decades and previously—*i.e.*, a good deal more than at present, as some of us can recollect.

Far more labour is employed upon the roads and railways than was the case in the decades referred to, and since that time many additional posts, not of an agricultural nature, have been created, the holders of which have absorbed cottages meant for agriculture.

But most of these cottages are required chiefly by weekly wage-earners, or market gardeners, or tradesmen and their assistants, persons of almost the same class as those whose dwellings

ought to be supplied by the landowners, for the needs of occupiers of their land. If built by speculators on building leases, or by small owners, the odds are that these cottages will be built as cheaply as possible, sufficient only to outlast the building lease, and cheaply built houses are usually uncomfortable and expensive to live in. It is far better therefore that such cottages should be supplied by the Rural District Authority, as the hands of the landlords are well filled already, in providing sufficient dwellings for the agricultural community, and they will contribute their share as ratepayers towards the erection of these.

For persons whose memories of a country-side do not comprise more than one generation, it must be somewhat difficult to imagine what considerations can have guided the selection of sites for the cottages that were built a hundred years ago, of which there still remain not a few in present use and still regarded with intense affection by those who have lived in them. The writer knows of one pair of cottages into one of which a young couple married 70 years ago, and they lived there for 60 years together. The pair was probably not new when the couple went into theirs, but the cottages are still in very good repair under probably a third or fourth coat of thatch. That pair stands on a good accessible site, but many of its contemporaries are to be found situated two or three fields away from any road, or under a wood on the side of a steep hill, or near a stream periodically subject to floods, or on ground so flat that drainage is a physical impossibility, or three hundred yards from any spring or well.

Whatever may have influenced our forefathers in the selection of sites in their day, these are considerations that we clearly enough cannot afford to neglect if we are to provide attractive habitations for an increasing rural population.

It is nowadays necessary for comfort that each cottage should be accessible with reasonable ease by the conveyances of the village tradesmen, therefore the cottage must not be many paces distant from a good hard road.

It is extremely desirable that cottages should be in groups, *i.e.*, (1) in pairs, for the sake of economy in building among other reasons, and (2) two or three pairs within a short distance of each other, if possible, so that the children may accompany each other to school and back, if there is a mile or two for them to walk, which is usually the case.

Also, the agricultural cottages should be placed, if possible, where two or three farms can be easily reached, so that the labourer should get a better market for his work—though for the younger men the

bicycle has rendered this consideration somewhat less important of late years. This, of course, has no bearing on the selection of sites by the rural authority for men whose occupation is not upon the land.

For the sake of health, it is also obvious that cottages should be so placed as to get both the early morning sun and also a fair amount of sun in the afternoon.

It is a mistake to build a cottage close to a wood or clump of trees, for the wind is nearly sure to have a tendency to blow the smoke down the chimney when it comes from over the trees which may have been considered a valuable protection to the cottages—the same thing applies to steep hills. A slate supported by four bricks across the top of the chimney may in such situations sometimes lessen the tendency to smoke, and not unfrequently cure it.

The effect of trees, or of dust from a high road, upon the cottage garden are also points not to be forgotten. No cottage ought to be built below the level of the road which it is near on account of the need of privacy in the bedrooms.

The windows of the upper floor ought not to be less than 30 inches from the floor, not less than 3½ feet high, and by far the best window is a lattice, each half opening outwards away from the centre, so that, whichever way the wind blows, part of the window may be opened in such a manner that the wind shall not blow into the room from either side. And a space of one foot is amply sufficient above the windows to the ceiling. It is a mistake to let the downstair rooms be too high from floor to ceiling because it means either too steep stairs, or too much space occupied by them. The arrangement of the stairs must be such that a full-sized coffin can be carried up and down them in a level or very slightly slanting position.

In every bedroom the doctor or nurse ought to be able to have easy access to the whole length of both sides of the bed. And provision should be made for the bed being placed at a safe distance from the fireplace.

There should be a fireplace (even if only a small one) in two upstair rooms. Three of every four cottages, or even a larger proportion, should have three rooms upstairs.

No fireplace should ever, if it can possibly be avoided, be placed in an outside wall; if one is so built, the odds are that the chimney will be inclined to smoke daily for a long time after the fire is lit (if not constantly) and anyhow a great loss of heat must be incurred.

It is very important to have two entrances to the house, and a porch to the front door is a very great comfort, as also is a lean-to

shelter to the back door, but there should as a rule be no lobby to the front door, which should enter the living room direct. A small second room with a small fireplace, too small for any kind of cooking, is a very great comfort and advantage. And one large hearth ought to be quite sufficient in the living room. If the "furnace" or copper for washing is in the house, it should be one which consumes its own steam; it is far better placed in an out-house or in the back porch.

Before the war it seemed to be taken for granted that economic rent is not to be thought about at all in connection with cottages for agricultural labourers. But, in the first place, that number does not comprise much more than half those cottages that will be required quickly in the country, or at any rate those that will have to be provided afresh. If agriculture is to be carried on in the national interest, the housing of the labourer is well nigh the first consideration, and cannot be treated as a matter connected solely with separate farms as part of the cost of production.

The question of the wages of the agricultural labourer having been so completely altered by the institution of a minimum wage, it is not an unreasonable assumption that in future the agricultural labourer will be able, and will be expected to pay, an economic rent, and that he will receive such wages as may enable him to do so. On the other hand, it is at the present time quite impossible to form a reliable estimate of the probable cost of a pair of cottages when they begin to be built again "after the war."

During the memory of the writer, the cost of a good pair of cottages had before the war risen from £360 to over £500—under the most favourable circumstances of material and haulage—probably £600 will not be an excessive estimate for a pair of what are now called good labourer's cottages, *i.e.*, such as to last at least 100 years in decent solidity and to provide not more than is necessary for a family of five or six persons to live in health and comfort, *i.e.*, two parents and four or five children.

That implies a weekly sum of 5s. 10d. to provide 5 per cent. on cost price which is the minimum economic rent for such a cottage, not allowing anything for repairs.

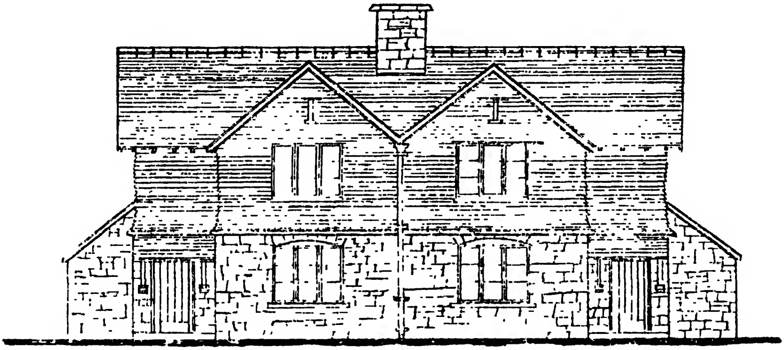
It is not unreasonable to hope that the Government will advance a certain proportion of the cost of properly built cottages, both to landowners and to rural authorities, to be gradually repaid in a limited term of years.

As regards the tenure of cottages, the rural authorities may be left to settle their own, with the stipulation that in no case shall notice to quit be less than a month. But the case is slightly different as

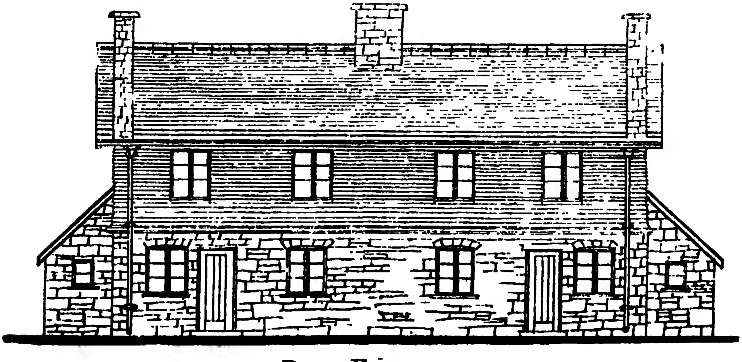
regards the agricultural labourer and his employer. The labourer must be so housed as to be able to sell his labour to the best advantage, but he must not be in a position to leave his master in a fix by a sudden and unreasonable change. The rent should be paid to the owner of the land and not to the farmer, and the repairs of cottages should be the duty of the receiver of the rent. In no case should notice to quit be less than a month.

It is essential that the farmer should have some control over the occupation of the cottages held by his shepherd, stockman, and carter, which cottages should be as near the farmyard as possible. If cottages are rightly placed, the employment or dismissal of other labourers will not be affected by, nor should it be allowed to affect, the occupation of these cottages.

There can be no doubt that, if agriculture is to hold the position that it ought to hold in Great Britain, the arrangements regarding



FRONT ELEVATION.



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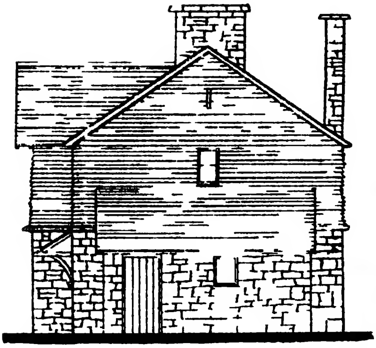
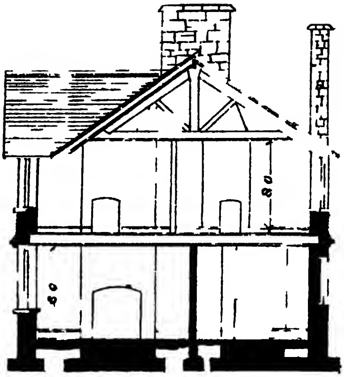
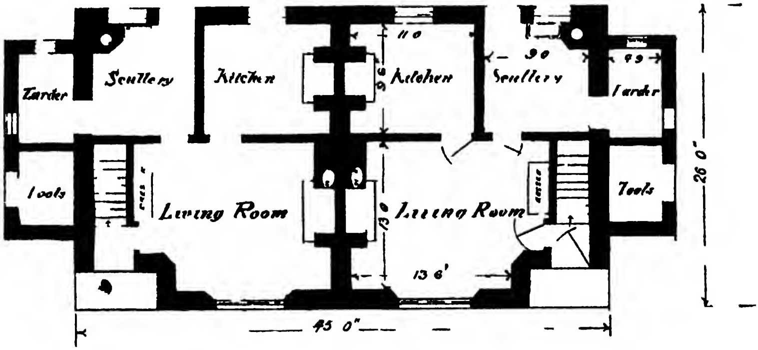


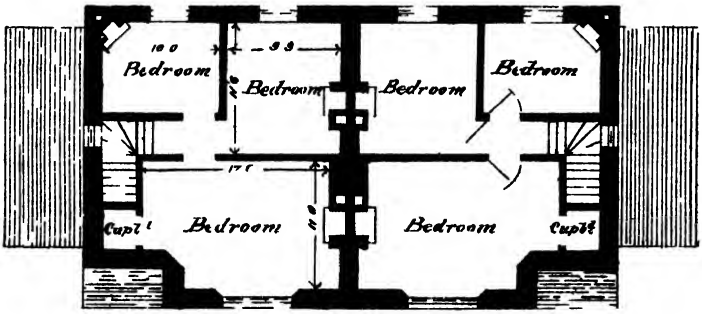
END ELEVATION



SECTION



GROUND PLAN



CHAMBER PLAN.

the dwelling of the agricultural labourer must be such as to attract, and not repel, the best brains and sinews that the class which depend upon manual labour can produce.

The plans and elevations here inserted are those of a pair of cottages which were built in 1916 at a cost of £520; out-buildings were added costing £15. The site was 850 feet above the level of the sea, which was the reason for covering with tiles the upper floor, which cost about £20, in order to keep off the excessive rain. The walls were of stone. The nearest station on a G.W.R. branch is 8½ miles distant.

Since the foregoing article was put into type the following notes have been sent to Sir C. T. D. Acland as the result of a conversation with him on the subject. They are so practical and useful that with the consent of the writer of them (Mary Countess of Lovelace) they have been here appended.

There is a widespread idea that beauty in a building is incompatible with health and comfort and, above all, that it must be expensive. In cottage building, at all events, that is not so. The two most essential rules are that a cottage should be kept broad and low and that it should be built of good local materials. If these are adhered to, it can hardly help being pleasant to look at in a homely way. The modern cottage is too often built of machine-made bricks and large thin slates (the worst possible roof) which have come a long distance by rail, while perhaps you would find close by local quarries or brick-kilns, out of which for centuries past all the best buildings in the country have been made. It is also a great mistake to think that all the ugly and mean modern cottages that we see are necessarily either comfortable or healthy. They are invariably too high for their size, and, in order to pay for the extra height and for the extra size of the staircase, the rooms are almost always miserably cramped in size. I was in a new cottage lately, built by what is called a "practical man," in which the living room measured 12ft. by 12ft., and had two doors and a sink in it. It faced north and looked into a back yard (the larder faced south-west!). But, of course, it was high. There was quite 2ft. 6in. of vertical space above the window-opening for bad air to collect in, and into which a large portion of the warmth from the fire disappeared and was lost. In our beautiful old West Country cottages the kitchens may be low, but they are wide and roomy, and there is always a good large scullery or wash-house for all the dirty work of the house. Of course the old cottages have faults—for instance, they often have no proper larders—and the rooms are often rather *too* low. I have known one that was barely six feet high, and

six feet three inches is quite common. But then, as a West Country woman once said to me, "we are not very *'igh* people." I think myself that the essential thing is to take care that the top of the window opening is not less than six feet from the floor; and by this I mean the *real* opening, not merely fixed glass or wooden frame. Fresh air should be admitted at the level of the human head, not of the waist. Above this six feet high opening, there must be a few inches for the window frame and the lintel over it, so that the ceiling cannot be less than 6ft. 6in. from the floor, and may be anything up to 7ft.; I have found the latter a very useful height. If you make it more, you will create an unnecessary and unwholesome space such as I have described above, and you will add to the expense of the staircase and to the labour of the housewife in keeping clean the extra steps required to get from one floor to another. In the old cottages, the windows are often too small. In the new ones, builders often rush to the opposite extreme and make them much too large; thereby forcing the inhabitants to go to great expense in curtains and blinds. And there is one fault that is constantly committed, that of making only one half of a casement window to open, while the other half is fixed. The window will then never open except in one direction, and in some winds it cannot be opened at all. If both halves open, then one can always choose which direction is most suitable for letting in air, and in fine weather how delightful it is to set both casements wide open!

I think it very important to make a good large porch, where a visitor can wait comfortably till the housewife is ready to admit him, and which also acts as a screen to the front door and enables it to be frequently kept open. People often keep flowers and all sorts of things on the window sills and prefer to air their rooms by means of the door. If the room is not more than 7ft. high, the open door will send a good rush of pure air round it and up the chimney and quickly wash out all impure air.

The question of whether cottagers want a parlour as well as their kitchen is often discussed. Old-fashioned country people are generally quite content to live only in their kitchens, provided they have a good scullery and some kind of shed or covered place at the back for stowing away unsightly things. But as wages increase, probably there will be more people who can afford extra furniture and an occasional extra fire, and they will tend to ask for parlours. If they are to have them, let it never be forgotten that, whether there is a parlour or not, the kitchen must always be the principal living room for working people for at least eight months of the year. The kitchen should, therefore, always be the largest room and have

the best outlook, and there must always be a scullery, for a sink in a living room is an abomination. If a washing copper is put in the scullery, it should always have an air-shaft immediately above it to carry off the steam. This should be carried up in the chimney-stack, independently of the flues, and have an outlet at the side of the stack just above the roof.

As to the bedrooms, these must be partly in the roof, if the cottage is not to be very much too high and horribly unsightly. There must, therefore, be some dormer-windows, but as much as possible the gable-ends should be used for windows. Generally speaking, the larger the roof is and the lower it comes down, the prettier the cottage will be, but the eaves should never be so low as to allow less than 4ft. 6in. of upright wall at the sides of the rooms inside.

Thatch, of course, makes the warmest and most charming of roofs for small houses. If only people would keep their chimneys always well swept a thatched roof would be as safe as any other.

The cheap, thin, blue slate not only is ugly, but fails to keep out heat or cold. Very large machine-made tiles are nearly as bad for the same reason, namely, that they can be used with very little over-lapping, and so they are a wretchedly poor protection. Either tiles or slates should always have a threefold "lap" to give the necessary thickness, and to allow of this they must not be large. Excellent small slates, cut very rough and thick, can often be found in small local quarries. They make first-rate roofs, and they look far better with white walls than tiles do.

VI.—SMALL HOLDERS AND THEIR CO-OPERATION WITH LARGE HOLDERS.

By Arthur F. Somerville.

LARGE AND SMALL HOLDERS IN NEW ZEALAND.

About 40 years ago I landed in New Zealand for the first time, and since then I have kept touch with this bright spot of the British Empire which in its people, climate, and place names reminds one so often of the Mother Country that gave it birth. Four times have I visited the Dominion, being closely connected with its wonderful development, and the fortunate owner of a small but beautiful estate in the North Island, which has kept its old Maori names. It is watered by a splendid river, and fringed by mountains, whose steep sides, which were covered by a dense forest in 1878,

are to-day divided up into well grassed paddocks, forming a fine feeding ground for flocks of Romney Marsh sheep and herds of Polled Angus cattle.

The story of the making of this "run" out of a picturesque wilderness of fern and forest into a productive estate, which is sending its wool, mutton and beef to the English markets, possesses all the elements of a deeply interesting romance; for it would tell of years of unproductive soil; of losses sustained by earthquakes and tempests; and of hopes and failings; leading up to the compensatory success ultimately attained. It is not, however, with a view to speak of my own personal experiences that I have made this reference to New Zealand, but in order to call attention to the marvellous development of agriculture in the Dominion and especially to the rise and progress of the small holders and the part they have taken in helping the larger holders of land to make their estates more productive. As in the home life the time comes when the children teach their parents, so it may be that the Mother Country, when dealing with the problem of the development of the small holder, will find something to learn from her daughter of the Southern Cross, and may gain something from the latter's past experience.

During the last 40 years New Zealand has seen many and great changes of Government. When I first visited it, the Government was in the hands of men of large property or connected with important business operations, who had a considerable stake in the welfare of the country, and were somewhat of the type of men who at that time formed the majority of the representatives in our own House of Commons.

These men, however, in a short time became unwilling to make the necessary personal sacrifice of time demanded by their public duties or to leave their properties and business which they considered suffered by their absence from them. This resulted in their places in the House of Representatives being filled by what, for a better name, I may call the middle class - small tradesmen,—and professional politicians. With the change of personnel came also a change in the payment of members. Previously there had been merely a small payment to cover out of pocket expenses, but now the members received a regular salary. Their reign was, however, a short-lived one, and Labour by combining obtained control, appointed its own Representatives, still further increased the salaries of the members, and practically ruled the country for the next 30 years.

Democracy and Socialism had their full fling and did not prove

themselves less corrupt than their predecessors. The real rulers were the Labour Unions, which exercised a tyrannical control over all public and domestic affairs till it seemed as if individual and personal liberty were to become a mere happy memory of the past.

It was then that the country districts, which, by the excellent system of small holdings, had become more and more populated, combined to fight for liberty. They threw off the domination of the towns, and, under the leadership of the present Prime Minister of New Zealand, the Right Honourable F. W. Massey, a new and happier era began and has continued.

Though thoroughly democratic, the country has, nevertheless, recognised the sacred rights of property and ownership, and now neither "Labour" nor "Capital" nor any other section of the community can exercise a tyrannical domination over the rest; law breakers are dealt with by a firm hand; and, under an excellent system of State-controlled arbitration, disputes between Capital and Labour are decided by the law of the land and not, as previously, by the arbitrary dictum of the Labour Unions.

But amidst all these changes of Government, and in spite of legislation of a decidedly Socialistic tendency, the country has always recognised that its real prosperity depended upon the prosperity of those engaged on the land and in work connected with it.

The Department of Agriculture, freed from political strife, has pursued the even tenor of its way and has exercised a paternal control over the thousands of settlers whom it had placed on the land, assisting them with both money at easy rates of interest and also with valuable advice as to the management of their farms and the cultivation of the land. It encouraged the formation of co-operative societies for the purchase of seeds, manures, and other agricultural requisites, and the establishment of cheese and butter factories. The produce of these factories was submitted to Government inspection to be graded, and, if defects were noticed, attention was called to them and, where necessary, special visits were paid to the factory by a Government inspector, with a view to discovering and remedying what was wrong. In every way this beneficent agricultural department has been ready and willing to help the small farmer on the road to success.

The result has been a steady growth in the number of owners and occupiers of land. In 1883 there were 25,400 owners and occupiers of land from 5a. to 320a., and some 2,700 owning or occupying from 320a. to 640a.; these numbers have gone on increasing so that, at the present time, the former class numbers over 40,000 and the latter more than 6,000.

A good deal might be said about these country homes where hard work and independence have produced that splendid army of men who, hand-in-hand with their brothers from the old country, are now fighting the enemies of liberty.

But it is not only to the successful progress of the small-holding movement and to the extent to which it has been assisted by co-operation amongst themselves, that I desire to call attention, but also to the benefit it has brought to the larger owners of land.

When some 35 years ago it was found to be more profitable to break up the native grass land, hitherto only used for grazing purposes, and to convert it into arable for growing grain and other crops, most of the larger owners had neither sufficient men, horses, nor implements to deal with the large areas they decided to cultivate. They, therefore, called in to their assistance the neighbouring small holders, who undertook the work by contract, the owner providing the seed. The land was ploughed, cultivated, and the crop got in and subsequently harvested, at so much an acre. I remember on one occasion seeing 26 reaping machines with their "army" of small holders in a single field; other men undertook the threshing and again others the cartage to the railway stations, these latter operations being carried out at so much per bushel. I have had work on some farms I then owned in New Zealand conducted on this system, so I can speak from personal experience.

By this means both the large and small owner benefitted; the former, with little or no addition to his permanent staff, was able largely to increase the returns from his estate, while the latter, even if he had had an unprofitable season on his own holding, got a very substantial return for his labour on the former's estate. In this way, many a small holder was in a few years able to increase his holding and stock, and I have known several men who began in quite a small way become the owners of large estates and rise to prominent positions.

APPLICATION OF THE SYSTEM TO THIS COUNTRY.

Now what has been done in New Zealand can, I believe, be also done, in a limited way, in this country to the advantage of both the large and the small holder of land.

In the Report of H.M. Commissioners on the "Administration and Practical Operation of the Poor Laws," which was issued in 1834, it was stated that—"there were many instances in which labourers were unable to obtain employment because they had property of their own." It would seem as if that same dislike to

the independence of the worker, and consequent disinclination to employ a worker who is not entirely dependent on his wages, still exists amongst some employers, for it is a fact that many large occupiers of land regard with no friendly eye the creation of small holdings, and have shown little or no inclination to employ the owners of these holdings. Another cause for their hostility is no doubt due to the displacement of the occupiers of large farms taken for small holdings and to the consequent fear that they too may be subjected to similar treatment.

It was very much the same in New Zealand, where the holder of a large Run, leased from the Government at a very low rent but subject to the right of purchase of the freehold, not only by the leaseholder but also by any outsider who applied, found sometimes the best bits of his land taken away for the provision of settlements and received very inadequate compensation for the improvements he had made and no compensation for the reduction of his stock consequent on the abstraction of this part of his Run. In many cases the Run-holder himself might have converted his Leasehold into Freehold but preferred to trust to luck hoping that no one would interfere with the occupation of his low-rented leasehold I speak of conditions existing 40 years ago; at the present time the power to purchase land direct from the Government is limited to a very small area. Consequently the Run-holder regarded these settlers on his Run as intruders who were doing him grievous injury, and, through their independent position, likely to cause friction between himself and his employees. As time went on, however, he began to find these new neighbours extremely useful when pressure of work necessitated the employment of more hands, and, as I have shown above, a system of co-operation was established to the mutual advantage of both the large Run-holder and his neighbour, the small settler.

Just in the same way in this country, if the large farmer would make use of the labour of the small holder, both classes would reap the advantage.

The position of the farm labourer has lately undergone a radical change, for the Wages Boards, which are now being established all over the country, have come to stay, and in the future it will not be, as in the past, a question of supply and demand or even skilled and unskilled labour, but probably, following the Trades Union rules, a wage based on a flat rate for the district for various classes of workers. If there is a sufficient supply of young active skilled workers, the farmer will be willing to pay the standard wage, but he will refuse to employ the old men and the unskilled labourers.

What then is to become of this latter class of workers? For them there would only remain employment by piece-work, for by this means alone could a farmer get value for his money, while the worker would receive as much as his labour was worth, and the price to be paid would be arranged by agreement.

I do not think that piece-work can be regulated by a Wages Board or that flat rates can be established for fencing, cutting and dealing with underwood, hoeing roots, thatching ricks, etc., where the conditions vary so much.

The probable result will be that labour on farms will be divided into two classes; work done by the regular staff earning a weekly wage (this class the farmer will keep as low as he can); and the piece-workers, who will carry on those minor operations on the farm for which the regular workers have not the time, nor perhaps the skill.

It is here, too, that the small holder ought to come in and help the larger farmer—as fencer, thatcher, cutter of underwood and faggoter, milker, hoer, and do countless other jobs. He could take his own time over most of the work, subject to any specified time for completing a contract, and, where, as in milking, his labour is only required for a few hours each day, he could, when necessary, devote the rest of the day to his own holding.

Now, although much has already been done towards increasing the number of occupiers of land and, under the auspices of the Agricultural Organisation Society, for the establishment of a system of co-operation amongst them, while the County Councils have, to some extent, established a system of instruction in dairying, poultry-keeping, horticulture, and other branches of agriculture, no sufficient efforts have as yet been made to properly organise the small holding community so that they may be able, not only to give reciprocal assistance to each other but also to provide a skilled body of men whose labour will be of use to the larger farmers and others requiring assistance. A man who depends entirely on his small holding is rarely in a better financial position than the ordinary labourer and has far greater risks. On the other hand, if he can devote a portion of his time to some other profitable employment, he can look to an income which is certain and which, too, will materially assist him in making use of his holding to greater advantage.

The larger farmer, if he can depend on the assistance of the small holder, will require a smaller permanent staff, fewer horses, and less machinery, and he will often be able to get in and harvest his crops in far quicker time than it would be possible for him to do with his ordinary staff of men, horses, and plant. There is, too, a very

serious demand for hauliers, a class for whom small holdings are especially adapted.

But to carry out this suggested scheme of co-operation between the large and the small holder we need to use far more discrimination in placing the right men on the land. We should seek to encourage those who have shown ability in dealing with agricultural operations such as the skilled ploughman, fencer, thatcher, milker and handy-man, and also those whose trades or occupations are closely connected with agriculture, including the haulier, carpenter, blacksmith, woodman, mechanic, saddler, thresher, and others pursuing trades of use to the occupiers of land.

Instructions should be provided for all those desirous of making agriculture, and trades cognate to its operations, their occupation for life ; co-operation should be on the lines started by the Agricultural Organisation Society encouraged ; financial assistance should be given by Land Banks ; Bull and Boar Societies, which have been established with such marked success by the Board of Agriculture, should be extended ; and, generally, facilities should be given for making the small holders' home a real home and sufficiently attractive to the dweller, to enable him to realize that the pleasures of country life can compare favourably with the attractions of the town.

Co-operation, therefore, between the large holder and the small holder is what we must look to in the future for the permanent success of agriculture. The farmer must be a better man of business, and, while knowing how work ought to be done and the value of labour, he must study far more the technical and scientific side of his occupation, leaving so far as he can the mere manual operations on the farm to his men. At the same time, the small holder must be a skilled workman not only competent to look after his own holding but also to give material assistance to his neighbour of the larger farm.

Further, the more people we can place on the land with a real interest in it, the better security we shall have against attacks by revolutionaries, who deny the right of anyone to reap the fruits of thrift and honest labour or to call the home he has built up by years of hard work his own.

The worker on the soil is necessary for the maintenance of that good old English bull-dog breed which defended her from the attacks of foes in the past and will, we feel certain, bring this fiercest of all her struggles for Justice and Liberty to a successful issue.

I quite admit that many of England's best and bravest soldiers and sailors have come from the towns, but it is well known that dwellers in towns after two or three generations deteriorate

physically and hence it is absolutely necessary to depend on those born and bred in the country to keep up the proper standard of physique.

From every point of view, therefore, it is desirable, in the interests of the nation, to encourage the placing of people on the land and to hold out inducements to them to remain there; there is no better or sounder method of doing this than by increasing the number of small holders. We must inspire the small holder with ambition by encouraging him to make the very best use of his holding and to regard it as a stepping stone to the tenancy or ownership of a larger one.

If mutual co-operation between the large and small holder can be ensured, we may look forward to placing on a still firmer basis that greatest of all our industries—agriculture.

VII.—OBSERVATIONS ON AN EXTRAORDINARY RAINFALL IN SOMERSET.

By R. Neville Grenville.

The extraordinary rainfall of June 29th, 1917, in the Brue watershed, in the County of Somerset, deserves, I think, on account of its abnormal character, to be recorded in the Society's Journal.

Up to the 20th of the month there had been ·43 of rain, on the 24th, ·25; on the 26th, ·05; on the 27th, ·20.

On Thursday, the 28th, there was some thunder in the morning with a few smart showers. At 5.30 p.m. the sky looked very threatening towards the south, and at 6 o'clock it began to rain in torrents.

In a couple of hours everything was afloat, and the water rushed in every conceivable direction. This went on till 6 a.m. on Friday, the 29th, when it blew hard from the east for a short time, and at 9 a.m., when the rain was taken, the gauge showed 5·76 inches.

The barometer, 29·8 on the 28th, rose to 30·3 on the 29th. The rain lessened by about 10 a.m., but the reading of the rain gauge on the following morning, Saturday, 20th, was ·23.

There are two other gauges in the parish, which generally tally fairly well with mine. These registered respectively 6·10 and 6·75, making an average of 6·20.

In the higher part of the watershed, at and near Bruton, the gauges registered as follows :—

Sexey's School, Bruton, 9·84in,
High Street, Bruton, 8·49in,
Pitcombe, 7·90in,

an average of 8·74 inches.

At Street, three miles below us, three gauges registered 5·13, 5·61, 4·86 ; averaging 5·20, making the total average for the watershed 6·71.

The heaviest rainfalls previously recorded at Street were :—

June 10th, 1860, 2·2″. June 11th, 1860, 3″. August 18th, 1868, 2·4″. July 14th, 1875, 2·52″. September 10th, 1885, 2·52″.

The river can manage to deal with 3″ in 24 hours, without undue flooding ; but when it came to 6·71″ in practically 12 hours, the banks overflowed all the way along.

On the morning of the 29th my Shorthorn cows were being milked in a field near the river. They were all milked but one, when a wave of water, 3ft. deep, was seen coming across the field. They were at once driven off to some immediately adjoining higher ground —but that cow was not milked till 12 o'clock that day.

The Guernseys were further down on the Moor, and had to be driven along a road with 2 feet of water rushing across it ; the men wading and the boy driving the milk cart. The horse got frightened and backed into a ditch—the milk was lost and the horse was just got out alive by a rescue party sent down afterwards. The boy, too, had a narrow escape.

Several other farmers had very narrow escapes in getting out their animals—one lost five sheep, and if the flood had been two hours earlier, a great many beasts must inevitably have been drowned.

A great deal of damage was done below Glastonbury, especially to potatoes and mangolds, and on the upper part of the Moor much hay was spoilt and washed away. Hay, if indeed it can be called hay, was actually being carried on the 7th of December. In some places the condition of the grass, after the flood subsided, was most extraordinary—in fact, there was no grass to be seen, and it did not begin to sprout again for several weeks ; the stumps of thistles that had been cut had become perfectly black, and it is to be hoped they are gone for ever.

The loss of the grazing was a very serious one, as for many weeks

after the flood the cows could not go back to their summer pasture at the time of its greatest importance.

My cows fell off in their milk to the value of at least £2 10s. a day.

I heard that the Meteorological Office in London thought there must be some mistake in the reading of the gauge at Sexey's School, so sent down to investigate the matter.

They were convinced that it was all perfectly correct—so to Bruton belongs the credit of registering what I believe to be the biggest rainfall in 12 hours in the British Islands.

VIII.—THE ECONOMIC VALUE OF FORAGE CROPS.

By James Long.

Apart from the fact that forage crops are always of great value on the farm for the feeding of stock, they are now more essential than at any time in our agricultural history. Farmers are requested by the Government to place an enormous area of grassland under the plough for the maintenance of our corn supply, with the result that grazing will be very largely restricted, and without some aid from the source to which I propose to refer great difficulty will be experienced in feeding our stock.

Pasture land--especially on the uplands and downs—is very subject to drought in hot seasons, and it sometimes happens that the average yield of grass is reduced to such an extent that large sums have to be spent in artificial foods, while the milk supply falls to a minimum. At the end of 1911 I made an estimate, based on information supplied by farmers themselves, of the loss of meadow hay owing to the severe drought of that season. The total deficiency was placed at 27½ million cwts., representing a loss of 5½ cwts. per acre. In 1912 the hay crop for England and Wales averaged 24½ cwts. per acre, one county falling to 8¾ cwts., another to 15¼, and several other counties to less than 17 cwts. In 1913 there was an increase to 25 cwts., and in 1914 to 21½ cwts., 18 counties falling below 17 cwts. to the acre. These losses are bound to recur from time to time, while our general average hay crop is never what it ought to be—especially as compared with that of Ireland, which is enormously larger, and of Germany, which rose from 22½ cwts. in the five years ending 1887 to 33·7 cwts. in the five years ending 1913. During similar periods our home crops fell from 26 cwts. to 23 cwt. per acre. I venture to point out that we cannot depend upon our

grass crop—whether for grazing or hay—under the new conditions, and that, supposing those conditions had not arisen, we ought not to be satisfied with a result which is unworthy of the agriculture of the country ?

Three years ago, when I was driven by a prominent Gloucestershire squire about a hundred miles through the counties of Gloucestershire and Worcestershire, I was struck by the poverty-stricken and brown appearance of the pasture lands on both sides of the road. This condition was not merely the result of want of manure, although that is a prominent feature, but on the higher lands it was chiefly owing to the shortness of the roots of the plants which, on soil subject to drought, were unable to obtain sufficient moisture to enable them to utilise the food which was at their disposal. During the dry season of 1911 I paid two visits to a large market garden conducted upon the French principle. The crops were growing with enormous rapidity owing to three factors: the richness of the soil, which was the result of manuring; the heat of the sun; and the abundant provision of water. This combination is such that under normal conditions green crops grow not only with great rapidity but with great luxuriance. If, therefore, it is impossible to provide water on the farm to feed the plants growing upon it, it is not impossible - so far as forage is concerned—to obtain excellent crops, if those plants are used which possess length of root enabling them by piercing to some depth into the soil to find water for themselves. It is remarked in "The New Earth" with regard to the Great American Desert, which is now being reclaimed, that it was once a sandy waste, consisting of millions of acres of arid land. "On one side of the road," says the writer, "spread the glossy green tops of the greatest lemon orchard in the world—fully 30,000 acres, reclaimed by the water impounded from the near-by mountains while on the other side of the road the trees were dead, their bare branches stretched towards the great hot sun and their roots held fast in the vice-like grip of the baked soil. Thus on the one side was a garden, and on the other—sixty feet away—the water supply had been abandoned by a thriftless farmer and the land was drifting speedily back to the desert." This is precisely what has occurred in a minor degree on a large area of English grassland which may be made to respond in normal seasons by the employment of basic slag or slag combined with potash.

Let me for a moment endeavour to arrive at the reason why the clovers and allied plants respond to mineral manures. I will take two concrete examples. On the large farm of Mr. Passmore, which includes some 2,000 acres of the South Downs, the pasturage

when I inspected it was covered with clover, solely owing to these manures, and land worth an infinitesimal sum was increased fourfold in value. The stock-feeding power of the farm has largely increased. There were 3,000 sheep, 420 head of cattle, and 70 horses; or more than twice the number kept by the previous tenant. It was also interesting to learn that the loss of ewes had been reduced from a high percentage almost to nil. But, on the other side of the fence, precisely similar land was growing plants which it has probably grown for centuries and was next door to worthless, for the herbage was coarse, inferior, brown, and without any clover.

My second example is taken from the downs on the Coombe Abbey estate in Dorset. Samples of turf had been sent me some two or three years before with a request for an opinion as to the course to be taken for its improvement. Mineral manures were suggested, with the result that a large part of the area which had been manured was covered with a carpet of clover, the rental value being increased from a few shillings an acre to 40s., which sum the bailiff informed me he would be glad to pay for it as a tenant. I visited other farms in Surrey, Warwickshire, Wiltshire, and Dorset, and found almost equally good results.

From examinations which I have made upon unimproved turf it would appear that the leguminous plants were just existing but unable to develop. With the employment of food in the form of mineral manure they are able during wet weather to extend both their roots and their leaves. Clovers are long-rooted plants, the roots of which immediately commence to grow and descend, and so they find food which they had previously been unable to reach owing to the restriction of their habit. This growth is continued in consequence, and in due course, as the roots find their way below and obtain water with food hitherto denied them, the foliage also increases and the clover—hitherto unseen—developes into a carpet.

About ten years ago I obtained from a London firm a compound manure for the purpose of improving a pasture which was of no immediate value at all. It was partially covered with patches of couch grass, the spaces between growing nothing, although traces of clover might be found. In eighteen months this field—previously the worst in the neighbourhood—produced a crop of white clover which reached almostc to my hips. The action I took was owing to the fact that a neighbour had obtained similar results on an equally inferior field where grasses, white and red clover, and alsike, were grown with equal luxuriance. Clover was the foundation of the success in each of these cases. It must be remembered,

too, that when an improved field of this character is grazed by stock their manure is enriched by the clover consumed and it contains much more nitrogen than can be produced from grass alone. As grass responds to nitrogenous manures and clovers to minerals, it follows that by improving the clovers and allied forage plants the grasses are also encouraged, but while the clovers prosper in very dry weather the grasses do not. This fact may be specially noticed in a field in which lucerne seed has been mixed—for the production of herbage—with grass seeds. Whatever the weather the lucerne grows rapidly after haytime is over and exhibits here and there distinct and large plants, while the grasses are failing to grow and are brown for want of moisture and food.

I regard the clovers as forage plants, inasmuch as they are commonly grown as separate crops, together with lucerne, sainfoin, trefoil, chicory, burnet, maize, tares, the kidney vetch, and the garden plant—the lupin—which is commonly used in Germany for the improvement of land. Where the farmer grows a mixture of rye grass and clover and sometimes obtains—as did a friend of my own—4½ tons of hay to the acre, he is growing forage plants which he may mow or feed off at his pleasure just as he feeds a mixture of vetches and oats or rye. With few exceptions it is the leguminous plants which thrive so well in hot weather, and at all times on suitable, well cultivated, and well manured soil.

In order to ascertain the relative length of the roots of a variety of plants I obtained a number of specimens from two large firms of seedsmen, together with seed which I planted myself. Most of the plants were imperfect, care not having been taken to dig them up to sufficient depth, with the result that some of the roots were broken off. The roots of a young plant of kidney vetch measured 11 inches in length and were provided with an abundance of root hairs. Had the roots been unbroken the length would probably have been 15 inches, while the roots of an old plant are considerably longer. This species, however, is not so well suited to the richer soils as to the sands and the poor soils of a hillside, on which it remains and grows with vigour for several years. A four-year-old plant of red clover, which had a broken root, was two feet in length. Judged by its stoutness, in all probability this plant would have been three feet in length had it been unbroken. A young plant of alsike possessed a tap root of 13 inches in length and this would probably have reached 16 inches had it been perfect. A trefoil plant, three-eighths of an inch in diameter below the crown, measured 15 inches to the end of the roots, and a plant of sainfoin was of similar length. In a permeable subsoil most of these plants

would have found their way to much greater depths, especially if the soil had been manured and was under good cultivation. The roots of a vigorous plant of Italian rye-grass measured only 4 inches in length, while those of an equally strong plant of perennial ryegrass possessing an extensive root system reached only 7½ inches. Timothy grass reached 9½, and Cocksfoot 9 inches in length, the latter possessing forty rootlets which covered a large area of soil, all being abundantly supplied with root hairs. The roots of a plant of Tall Oat grass reached 8 inches, and here also the numerous rootlets were vigorous. On one occasion I measured the length of two plants of Tall Oat grass and Timothy on rich soil in Switzerland. Each measured between 5 and 6 feet from the ground to the flower. Both Cocksfoot and Tall Oat grass as well as Tall Fescue are adapted for mixing with the leguminous and other forage plants and are suited to poor, dry soils, although their root systems are smaller and the length of the principal roots much shorter than those of the legumes. A strong plant of Burnet— an excellent sheep food—reached 10½ inches, and this was intact, while Chicory reaches from 18 inches to 5 feet in length, the diameter of a plant grown by myself being seven-eighths of an inch below the crown.

It will be remembered by those interested in this subject that the late Mr. Elliot, who owned a farm in Scotland, commenced a series of experiments some twenty years ago which were highly successful. The land was poor and stony and had not been manured for seventy years at least, while it ran up to an altitude of 750 feet. The two fields which were first attacked were ploughed up and sown with a mixture of grasses and forage plants including chicory, burnet, kidney vetch, and some of the clovers with cocksfoot, tall oat grass and tall fescue. Some of the most popular varieties of the Graminaceæ were omitted, including foxtail, timothy, sweet vernal, poa pratensis, and rye grass. One of the results was that, on the improved pasture which followed, as many sheep were fed upon a 22 acre field as were fed upon 87 acres on a neighbouring farm, whilst the large number of long roots forming part of the plants making up the pasture improved the soil to such an extent that after it was ploughed up large crops of turnips and potatoes were grown, together with a corn crop that formed part of the rotation.

One of the primary ideas of the experimenter was that a turf would be produced in the course of a four years' ley which, owing to the nature of the plants composing it, together with their root systems, would enable him to grow arable crops without manure, and as a matter of fact he was able to do so. The inclusion of the

forage plants named in the mixture of seeds not only fed the sheep right up to the 20th of May in the following year, but produced two tons of hay to the acre, a weight which it was believed would have been exceeded but for the exceptionally dry season which followed. It was due to the forage plants sown that the luxuriant herbage upon one of the poorest of soils, provided twelve weeks grazing in autumn and spring and a hay crop of two tons to the acre. The owner of the land stated that for seven years afterwards this field carried 50 per cent. more stock than land of similar type in the district outside of the estate. These facts are practically confirmations of the work of Schulz, of Lupitz, who introduced a system of reclaiming practically worthless land. This land was called the Desert of Lupitz when taken in hand by Schulz—who had been educated at an agricultural school and a University. He purchased the property—740 acres in extent—at a cost of some 12s. an acre. The soil of this farm was a diluvial sand, practically without lime and with scarcely any potash, phosphoric acid or nitrogen although it contained iron. The subsoil, too, was of a similarly sandy character. For the purpose of taxation the value of this land was fixed at from 9½d. to 1/2½ per acre. No dung was employed in its treatment, but for some twelve years the lupin was exclusively grown with the assistance of kainit and basic slag. Thus the subsoil was enriched with organic matter of great value. With the accumulation of the essential fertilisers which the lupin provided, fine crops of wheat, barley, and oats were produced, and in succession potatoes, beans, turnips and clover, the potatoes occupying about one-quarter of the entire area. It was, however, not until the expiration of a quarter of a century that the barren soil showed great fertility. This had a powerful influence upon the agriculture of Germany, and Schulz came to be regarded as the apostle of a system of reclaiming almost worthless land.

I have had the advantage of witnessing the system of cropping grass in the Canton of Zurich in Switzerland, where I have frequently stayed for some weeks at a time. The cows, which are numerous, are stalled throughout the year, receiving in summer a mixture of grasses and forage plants mown and carted to the farm, the land being dressed immediately after the scythe with both liquid and solid manure. Owing to the fact that on most of the pastures fruit trees of large size are planted sufficiently wide apart to prevent damage to the grass, yet close enough to prevent the hot sun drying it up, there is no loss in a season of drought. Instead of its being mere pasture grass as with us, the seeds are mixed with lucerne,

sainfoin, clover, plantain, dandelions of gigantic size, and other plants which we commonly recognise as weeds, but all of which contribute to produce herbage so abundant that in some cases the hay made in a season is equal to five tons to the acre. It is difficult to underrate the importance of deep cultivation by subsoiling, although, unhappily, there is not, so far as I am aware, any subsoiling tool in the market sufficiently perfect for the work. As forage crops are temporary, it follows that not only should the land be ploughed deeply but that the subsoil should be moved with the double object of enabling the long roots of the plants growing above it to find their way into it, and to obtain water and food. We may regard the subsoil when it is cultivated as adding an additional area of land to the farm. Below the pan existing upon almost every corn farm there is an untold wealth of minerals suitable for the feeding of plants which only need decomposition by the introduction of light and air. Apart from this, the deeper the soil is moved the more perfectly it is sheltered from drought. For example, hoeing the surface soil to some depth is the secret of the dry-farming system in America. When particles of soil are packed close together water rises, and unless the surface soil is loose, it evaporates. Where, however, the surface soil is hoed to a depth of 3 to 4 inches the soils loosened acts as a mulch, and capillary action is checked together with evaporation.

Forage crops, like grass, should be mown at the earliest possible moment. This gives more time for subsequent growth and conduces to the production of a tender, succulent, and rich herbage. This, however, is reduced in nutritive value when the seeds ripen and are shed. The following is a brief description of those forage plants, the nature of which should be better understood.

LUCERNE.

Having grown this plant for many years in succession I am able to testify to its marvellous value. It is difficult to sow with the ordinary drill, and for this reason it is often broadcasted, but if to the lucerne seed in the seed-box sufficient quantity of red clover is added, the cups will work satisfactorily, while the crop in the first year will be considerably greater than it would otherwise be. The late Sir John Lawes once showed me lucerne roots at a depth of 18 feet below the surface at Rothamsted, which shows to what depth they will penetrate in search of water and food. For some unaccountable reason the growth of lucerne is chiefly confined in this country to the eastern counties, and in normal times I have known local dairymen pay farmers £10 an acre for the privilege of cutting it.

Three crops can be mown, and a fourth usually grazed by cattle or horses. In France lucerne is cultivated to an enormous extent, covering 2¾ million acres, while in this country it covers only some 54,000 acres. It makes excellent hay, which is suitable for either cattle or horses, and it can be grown on a variety of soils. The most suitable are soils of some depth which contain lime and are sufficiently substantial. In the west of Brittany, very near the seashore, I have seen lucerne growing on various small farms on very light sandy land, with granite below. Its success—which was not unqualified—was owing to the persistent efforts of the occupiers to cultivate it. Lucerne prefers dry land with a southern aspect, but at not too high an altitude. It has succeeded experimentally in the West of Scotland, and if the land is in excellent order it will grow a considerable quantity of forage in the year of sowing, although this is not usually believed. I adduce two proofs of this—as well as of the importance of selecting land which it is known will suit the crop. A field of some thirteen acres was sown with barley and subsequently drilled with lucerne. A small portion of the field was dunged, the remainder being dressed with basic slag. In due course the seeds germinated and the plants commenced to develop, but, with the exception of those sown upon the dunged land, every plant died. The living plants grew with rapidity, and at harvest time the crop reached a height of 14 inches. The land was exceedingly poor, and had been down in pasture for many years. In 1916, I sowed some example plots, on deep stiff soil, with lucerne, sainfoin, clover, and various grasses, during the first week of June. By the middle of September, the lucerne, sainfoin, and clover had reached a height of some 16 inches, and was thick enough to mow. This shows, therefore, that seeds of these plants can sometimes be sown as late as June and provide a crop in the first year, which in the cases quoted, would have been considerably greater than the average hay crop although the seeds were not sown with corn.

In sowing lucerne, the seed should be drilled at the rate of from 12 to 14 lbs. to the acre, or broad-casted with 20 lbs. The soil should not only be clean but in good condition. If the seeds are not well-covered, they may germinate and be killed by the sun, and care must be taken to prevent this. As the plant will remain down from seven to eight or nine years, it is worth every attention. It requires little or no manuring during the whole period, and the fact that it responds to a hot sun in a season of drought, prevents the loss of a crop. Lucerne is excellent for horses, cattle, and pigs, but I have never given it to sheep.

SAINFOIN.

Sainfoin—like lucerne—is usually sown with a corn crop in Spring. It is practically perennial, but the common seed of the country, obtained from a neighbouring farmer, is safer than the seed of the Giant variety, or that which is imported. Sainfoin is a leguminous plant, and a collector of nitrogen, and the great depths to which its roots penetrate enable it to enrich the soil for the benefit of the crops that follow it. I know of no plant grown on the farm which is of such real value to sheep in poor condition. It acts almost medicinally, and they are extremely fond of it. The area of sainfoin grown in this country is so small that it has no place in the Agricultural Returns, and yet in France it covers nearly two million acres. In England it is common to a few districts, and does not seem to expand, although it is of great value for horses whether as green forage or hay. It produces a large crop in the driest summer, and if for no other reason it should be grown wherever the soil and climate are suitable. Southern sheep farmers occupying chalky land find sainfoin admirable. The seed is sown in two forms: in the pod —when it is customary to sow two bushels to the acre—or after milling, when 40 or 50 lb. are sown, the greater weight being broadcasted, and the smaller weight drilled. A bushel of seed contains about 23,000 pods, an acre, producing from 28 to 33 bushels.

Where sheep are turned on to a crop of sainfoin the fold should be small to commence with, or they are liable to eat too large a quantity. Pigs may also be folded upon sainfoin, and they will thrive well upon it during the summer season, the hurdles must, however, be stronger than for sheep. Although the plant is practically perennial it should not be mown too often. Grazing is better, and enables it to remain longer upon the soil, not wearing out so quickly. Two cuts, however, should never be taken in one season, this plan being very detrimental to its perennial property. In course of time, like lucerne, it is overcome by the natural herbage, as this gets a better hold upon the soil. Although farmers outside sainfoin districts are apparently unwilling to grow it, they will in most cases, where the climate and soil are suitable, find it to their advantage to plant an experimental acre.

THE KIDNEY VETCH.

This plant—well-known to collectors of wild flowers as "Ladies' Fingers"—has become highly popular as a forage plant upon poor light soils. The kidney vetch belongs to the leguminous family, and is one of the Anthyllus, of which there are numerous

species. It has done good ervice in a mixture of grasses and other forage plants, and, even in dry seasons, has produced a rich and comparatively luxuriant crop. The flowers, which are bright yellow, sometimes tinged with red, giving a gay appearance to the ripening herbage, are supported by a stem carrying pinnate leaves. The kidney vetch will not thrive upon land which is cold or wet, but it is a deep feeder, and finds water and food to enable it to produce abundant foliage when ordinary pastures are dry. It is a nitrogen gatherer, and for this reason, when ploughed at the end of four years, the roots form an important item in the future enrichment of the soil. A sample of seed should be 98 per cent. pure, and when added to a suitable mixture, 4 lbs. will suffice. It is always better to graze the crop the first year.

CHICORY.

This plant is of great service on deep soils at a fairly high altitude, where drought prevails. It is said to have been introduced, in its cultivated form, by Arthur Young, who, when travelling in France, recognised its prolific character. It was then regarded as an excellent stock food, especially for horses and cattle, and useful in the production of milk. Chicory is a strong perennial, with long, powerful, penetrating roots, which render it independent of dry weather. This plant has been found to penetrate from two to five feet below the surface, although with age it becomes tough and fibrous. It is grown by small holders in continental countries, and is cut green from three to four times in a season, providing a large weight of fodder on each occasion, but it must be mown before the appearance of the flower. Under usual conditions chicory can be grown for five years in succession, and it sometimes remains longer. Where the roots are used for roasting and mixing with coffee, they sometimes weigh from 8 to 9 tons to the acre. On a Scottish farm the roots of chicory have been traced to a depth of 22 inches at the end of five months, 30 inches at the end of fifteen months, and 5 feet when the plant was mature. It is not a soil exhauster but a soil improver, the great weight of roots after decomposition materially increasing the fertility of the soil. It is better for grazing than for mowing, as the leaves are apt to give trouble in the process of curing, although this has to a great extent been overcome. It is well adapted for sheep, will grow upon sandy or chalky soils, on which it forms an excellent change, increasing the organic matter. The seed, which weighs 36lbs. to the bushel, should germinate at the rate of 80 per cent., while the number of seeds in a pound is estimated at 270,000.

MAIZE.

As an old grower of the maize plant for green forage, I can speak with entire confidence of its value. It forms the principal forage plant of the United States, and is chiefly grown for winter food for cattle, for which it is preserved in the silo. It has been officially estimated that there are 400,000 silos in that country. It is important in growing maize to obtain the right seed, which is usually white, and I have been accustomed to buy it in France. The great advantage of maize is that it can be sown on the 1st of June, after the removal of a previous forage crop, such as vetches, rye, or trifolium.

The best method of sowing is to strew it after the plough, and to cover it with a second plough, sowing only in alternate furrows, afterwards harrowing and rolling it tight. Where broad-casted or drilled, rooks are certain to find it and to destroy all prospect of a crop. In any case, the rook will attempt to pull up the young plant as soon as it appears for the sake of the remainder of the seed. For this reason I have found it essential to protect the crop by stringing black thread from stake to stake, about four feet in height over the entire field, and the crop is worth this trouble. On good, deep, well-manured soil—and phosphates are most advantageous—it is not difficult to obtain from 35 to 40 tons of forage to the acre. Such a crop I examined on the farm of Mr. Percy Nevil, in Kent, in the past autumn. In my own case some crops have been so high that wagons and horses could have been driven into them and entirely lost to sight. On a hot, moist, summer's evening, anyone quietly standing in a growing crop of maize can hear the leaves pushing themselves through the joints almost with a crack; this fact giving rise to the remark that under suitable conditions maize can be heard to grow. It can be cut in a hot summer—for it ignores drought—from the end of August until the cold weather of October arrives when it is easily killed by frost. Unless left too long, every particle is edible, and it can be taken to the pastures for the cattle to eat just as it is cut. When ensiled it is passed through a large chaff cutter and blown into a silo, in which it is easily preserved.

Maize is remarkably superior to a leguminous plant like vetches. A 20-ton crop, which is a small one, provides 3,900 lb. of non-nitrogenous and 315 lbs. of nitrogenous matter, whereas a crop of 10 tons of vetches—also a moderate crop—provides 1,360 lbs. of non-nitrogenous and 560 lbs. of nitrogenous matter per acre. Maize, however, can be grown to a much greater weight than these figures represent, while vetches cannot.

BURNET.

Burnet, which is commonly regarded as a weed, is a perennial plant adapted to soils containing sufficient lime, and it reaches a depth of 20 to 36 inches. It produces from five to ten pairs of leaflets, of oval shape, with compact clusters of flowers, and is specially adapted to poor land of deep staple. In the past, Burnet was sometimes cultivated as a special crop for sheep, but it is doubtful whether any living man has seen it occupying a field by itself. It is now known to be specially valuable for mixing with grass and clover seeds, especially on poor dry land, for owing to the length of its roots, it is practically independent of drought, growing with great vigour and obtaining both food and water when both are out of reach of the finer grasses. Although it provides some spring herbage, its greatest growth is in summer. It is believed to have an excellent medicinal effect on sheep that need a change of pasture, Arthur Young remarking that they preferred it to turnips. It has been reported of Burnet that its flavour is strong, and that in consequence it should be sown in small quantities at first, with a view to ascertaining whether it is suitable to the soil. There are no two opinions as to its suitability for cattle and sheep, while it has been claimed to improve the value of both butter and milk. Under ordinary conditions it is difficult to find a plant of Burnet that is other than green, drought having no perceptible effect upon it. Mr. Elliot regarded Burnet as a drainer, aerator, and tiller of the soil, and, like chicory, specially adapted to break up a hard pan. He states that he has removed a plant of Burnet, the tap root of which had descended straight through a pan nine inches thick and into the hard clay beneath it to a depth of 26 inches. This root was an inch in circumference near the surface and threequarters of an inch a foot below. Arthur Young, who regarded rye-grass as an exhausting plant, refers to Burnet as an improving plant, as it certainly is, a fact which can be ascertained by ploughing up land in which it has been abundantly grown. The seeds number 75,000 to the pound, and may be sown up to an altitude of 1,600 feet. They are in capsules some of which contain two kernels, and germination should be at the rate of 140 per cent. No plant known in British farming is hardier in cold weather, or grows better during drought, than this excellent forage plant, the seed of which cost about 5d. a pound before the war.

TALL OAT GRASS.

Tall oat grass has been highly praised from the time of Arthur Young by some of our best observers. It is sometimes described

as false Oat grass, but its prolificacy, and its adaptability to dry soils and high altitudes sustain its claim to be regarded as a valuable fodder grass. It is a strong-growing plant, sometimes reaching 4 feet in height, specially adapted to medium and approximately heavy loams, and the spreading character of its flowering panicles gives it a handsome appearance. Owing to the bitterness of its flavour it is not adapted to growing alone, but this flavour is not perceptible when it is consumed in mixed herbage. It is quite an early grass, flowering during the first week in June.

TALL FESCUE GRASS.

Tall Fescue Grass (*Festuca elatior*) has long been known to the botanist, the seedsman, and the farmer as a good cropping and useful fodder grass. There are, however, various opinions as to its character. It was said by Carruthers to be the *Festuca arundinacea* of Germany; Sutton describes it as indigenous; while Hunter states that two kinds of seed are sold to farmers under this name, one known as the Tall Reed Grass of New Zealand, has very poor feeding properties and is quite unsuitable for the purpose in view. Tall Fescue has long been regarded as an early-cropper and a drought resister, growing especially well upon dry chalky soils. It grows from four to six feet in height, although the latter figure is seldom reached. It is suitable for poor, deep, dry soils, including those at a considerable elevation, and it will grow up to from 1,200 to 1,300 feet above sea-level. Tall Fescue flowers by the end of June. The seed, which weighs 24 lbs. to the bushel, germinates at the rate of 95 per cent., the average number of seeds to a pound reaching 246,000, of which 236,000 should germinate.

IX.—SOME SERIOUS POTATO DISEASES.*

By S. Leonard Bastin.

It is rather a curious fact that our most important garden crop is comparatively free from the attacks of animal pests, for there are few insect foes in the British Islands whose attentions are exclusively directed to the potato crop. Now and again, in certain districts, wireworms carry on their pernicious

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activities, but, in a general way, these do not cause great anxiety to the potato grower. The ubiquitous slug, although it attacks the tubers when it can get at them, hardly ever touches the foliage, which is, perhaps, too rough to provide a satisfactory meal. Here and there, in different parts of the country, an animal pest may be discovered making itself a nuisance in the potato plot, but it is unusual to find widespread damage due to these agencies. When we come to the vegetable foes of the potato the story is an altogether different one. There is probably no important crop which is so likely to be attacked by one or other of those insidious fungoid bacterial pests that have been the bane of the plant grower from time immemorial. The great danger of these foes lies in the fact, that often enough, in the early stages of the onslaught, they are little in evidence. For instance, a particular tuber which appears to be excellent "seed" may have in it the resting spores of some fungoid growth. Granted reasonably suitable conditions, these spores are certain to develop and there is small chance of the tuber developing into a satisfactory potato plant. Nowadays, when abundant crops are of such vital importance, it is impossible to exaggerate the need for a close study of the fungoid bacterial pests of the potato. In the present paper it will be the endeavour of the writer to describe each of the leading potato diseases, at the same time giving practical hints as to the best means of resisting the trouble. Seeing that all these minute pests are difficult to fight, too much stress cannot be laid upon the value of prevention. More and more is it being realised that healthy stock growing under good conditions does not easily fall a victim to disease.

THE POTATO DISEASE (*Phytophthora infestans*).

This fungus is one of a small group of parasitic species closely allied to the Peronospora which are largely responsible for the moulds and mildews of the garden. Not a large number of species of Phytophthora have been described, but of these by far the most important is *P. infestans*, a pest which has distinguished itself to such an extent that it is known as the Potato Disease. Some of us are old enough to remember the time when this trouble first became prominent. Prior to 1845, although the Phytophthora was known it had never been seriously regarded. But, in August of that year, it appeared practically all over Western Europe as well as in the northern parts of America. In Ireland the potato crops (the chief source of the people's food) were so badly blighted that dreadful distress followed the visitation. In some parts of the country the

disease threatened to make potato culture almost impossible; happily these fears have not been realised to their full extent, but since 1845 the Phytophthora has always been a menace. It should be remembered that the pest might get the upper hand again with disastrous results.

LIFE HISTORY OF *Phytophthora infestans.*

All growers are unhappily familiar with the appearance of the Potato Disease. (Fig. 1.) After a spell of damp weather there will appear on the leaflets, or sometimes on the stalks, dark patches usually more or less rounded. These increase in size and gradually change from brown to black. As the days go by these diseased patches become rotten towards the centre, and finally the leaflets may be riddled with holes. If the underside of a patch is examined it will be seen to be covered with a whitish mould, particularly thick towards the margin. All the time the actual fungus is growing within the tissue of the plant, feeding upon the store of nutrient matter which the plant has collected for its own use. This vegetative process of the fungus, technically known as the mycelium, is in the form of threads which are lying in close contact with the cells of the leaf. The mould, which can be seen, is simply the reproductive system. An enlargement of this mould reveals the fact that it consists of branching filaments; these bear a number of spores at their tips. The spores of the Phytophthora are produced in enormous numbers and, owing to their lightness receive a wide distribution through the agency of the wind. That a certain number of the spores are sure to settle on the foliage of fresh potato plants is obvious. The next stage in the development of the spores must go forward in the presence of water, this is likely to exist in the form of dew or raindrops on the foliage. It is well known that long spells of damp weather favour the spread of the Phytophthora and this is due to the fact that when the foliage is wet there is no check in the development of the pest. Where the spore is immersed in water, such as a dewdrop, it soon divides into five or six small egg-shaped masses, known as zoospores. Each of these is furnished with two hairs (cilia) by means of which they can swim about in the drop of water. After a while the zoospores settle down on a suitable position and eventually there occurs an outgrowth of the mycelium which penetrates the tissue of the leaf and in this way a fresh centre of infection is set up. Thus, where the conditions are favourable for the spread of the disease, a single potato plant may be responsible for the infection of a whole field. The mycelium of the Phytophthora will soon spread throughout the entire potato

plant eventually even reaching the tubers. Besides this, the tubers are often directly attacked by the spores. Seeing that the spores are mostly produced on the under side of the leaves the majority of them will fall to the ground. Rain will then wash them down into the soil and, when they reach the tubers, germ tubes are produced; these penetrate the skin of the potato and develop mycelia, which carry on the destructive work in the tissue. By far the greater number of the tubers attacked by the Phytophthora will finally rot away. The process of decay is usually hastened by the entrance of other minute fungoid organisms which help to complete the work of destruction. A certain number of the tubers will survive and in these will be preserved elements of the fungus mycelium. During the winter this will remain in a more or less inactive state, but plants grown from tubers thus in-infected are likely (though this is not invariably the case) to be diseased. In some quarters it has been thought, and the point is still a contested one, that the Phytophthora pass through the winter in the form of special resting spores. A long time ago curious globular cells were observed in diseased potatoes, and it has been positively asserted that these are connected with the mycelial growth of Phytophthora. Similar bodies have recently been obtained in cultures. However, this may be, the chief matter for the grower's consideration is that the Potato Disease fungus does hibernate and can start away with great vigour when the warm weather comes round again.

It has been recently suggested that the sudden widespread appearance of the Potato Disease in the autumn may be explained on the following lines. It has been advanced that, on occasion, the fungus lives symbiotically (that is in a state of partnership) in the cells of the potato plant. In this state the fungus is a shapeless mass of protoplasm (living matter). Under suitable conditions the protoplasm protrudes into the spaces between the cells, there to form a fungal thread. Male and female threads arise followed by the formation of a fertilised egg cell from which one or more sporangium-bearing threads pass out through the leaf pores into the air. In this way the disease is spread.

WHAT HAPPENS WHEN DISEASED TUBERS ARE PLANTED.

It is naturally very desirable to secure the "seed" from a stock quite free from Phytophthora. In the early stages of attack it is not by any means easy to say whether a tuber has the mycelium of the fungus in it. A close examination will generally reveal a

darkening of the skin around the affected part. At a later stage these dark patches become depressed and take on a deeper hue. On being cut open such a potato will show a curious red colouring in the region just below the skin. Where the disease has secured a very firm hold on a tuber the coloured part extends towards the centre of the potato. A very large number of slightly diseased potatoes are planted every season. In the majority of cases these will simply rot in the ground and no plant will arise. A proportion of the tubers are, however, likely to grow and some of them may give rise to plants of considerable vigour which, unless they are re-infected, will develop well both above and below ground. On the other hand, just a few will send up miserable shoots that are heavily infected with disease right from the start. These are centres from which the trouble may be distributed over wide areas. Now and again crops are infected from sprouts arising from diseased tubers that have been stored away in the winter, these being left about in the open just long enough for the spore production to begin. Sprouts of diseased potatoes and any useless tubers should be buried deeply, or, better still, destroyed by fire. It is inviting trouble to let them lie about.

PREVENTION OF POTATO DISEASE.

Since the Potato Disease is practically incurable, although, as will be shown later, it can be controlled, prevention is of first-class importance. Healthy "seed," as we have already observed, is of paramount consequence. In a general way sprouted tubers are less likely to fall victims to the pest. This is worth noting for the practice of sprouting has been shown to result in an increase of about two tons per acre in the crop. Disease resisting varieties should be selected. Some of the varieties that have been long in cultivation are especially prone to develop disease. This is not invariably the case, however, and it is not safe to conclude that a new variety will necessarily be a better disease resister than an old one. Close planting is calculated to increase the risk of disease. Hardly any of the fungoid pests flourish where there is plenty of light and air. Deep "earthing-up" helps to prevent the spores of the Phytophthora from reaching the tubers. Finally, the selection and storage of tubers is a matter that should be carefully carried out. All damaged, or apparently diseased, potatoes should be rejected at once. Those which are retained should be put away in a dry condition in a well ventilated clamp. With free ventilation and a generally dry condition the disease, even if it should appear, will not spread rapidly in a clamp.

WHAT TO DO WHEN THE CROPS ARE DISEASED.

It has been said that there is no cure for the Potato Disease, but it is a fact that the trouble can be very largely controlled. Everything depends on prompt action seeing that, in certain conditions, the pest spreads with such great rapidity. Without a doubt the most effective means of dealing with the potato blight is to spray the crop either with Burgundy or Bordeaux mixture. (Fig. 3.) There is a tendency to introduce spraying as a normal feature of potato culture and this is all to the good. Except in the case of the very earliest crops, which usually mature before the blight has much chance to make headway, it is probably always a wise course to spray. The two solutions which have given the best results are Burgundy and Bordeaux mixtures. A few suggestions on the preparation of these spraying mixtures may be of interest. Burgundy mixture is formed of copper sulphate, washing soda, and water. The 1 per cent. solution, which is considered to be sufficiently strong for ordinary purposes, is made up in the following proportions :—

Copper sulphate	4lbs.
Washing soda	5lbs.
Water	40 gallons.

During a wet season, or when for any reason the mixture cannot be applied thoroughly to all parts of the plant, the mixture might be of double strength, that is 2 per cent. The mixture may be readily prepared in a 40 gallon paraffin barrel, into which, after it has been washed out 35 gallons of water are placed. The copper sulphate is first of all dissolved in this water, the soda being dissolved in the remaining five gallons of water. It is then poured slowly, and with a good deal of stirring, into the copper sulphate. If the mixture is not required for immediate use the two solutions should be kept separate, until such time as the spraying is taken in hand. It is recommended that the mixture should be tested to discover whether there is a sufficient amount of soda in it. This may be done by dipping a piece of red litmus paper in the mixture. The red litmus paper should turn slightly blue if the proportion of soda is correct. If it remains red more soda solution should be added. It is of the utmost importance to secure pure chemicals of 98 per cent. purity, and a guarantee to this effect should be obtained from the seller.

Bordeaux mixture as a fungicide was first used in the vineyards of Bordeaux. It is prepared with copper sulphate, freshly burnt

quicklime and water. The following proportions allow for a 1 per cent. mixture.

Copper sulphate	.. ..	4lbs.
Freshly burnt quicklime	..	2lbs.
Water	..	40 gallons.

A 2 per cent. solution which might be used under similar conditions to those indicated in the case of the Burgundy mixture is prepared by doubling the amount of the chemicals. Lime of the best quality should be used if it is possible to obtain this. Ordinary builder's lime may be rendered suitable if it is freed from gritty matter and is quite fresh and unslaked. The preparation of the Bordeaux mixture is on the following lines. The copper sulphate is first of all dissolved in 35 gallons of water. The lime is put into a separate vessel and slowly slaked with a small quantity of water. When the lime has been reduced to something resembling cream, water is added up to five gallons. Stir well and pass through a fine sieve, last of all adding it to the copper sulphate solution, stirring vigorously all the time. A well prepared Bordeaux mixture should have the following appearance. A gelatinous precipitate ought to be formed in the barrel. This takes a very long time settling down. Where too little water has been added to the lime or the stirring has been neglected the precipitate is of a coarse, almost gritty, nature, which soon settles to the bottom of the barrel leaving a clear solution. Such mixture is not much good as a fungicide.

It has been shown by recent trials that there is little to choose between Burgundy and Bordeaux mixtures as regards their action as fungicides. On the whole, a Burgundy mixture adheres to the foliage rather better than the Bordeaux. The amount of soda should not exceed that indicated or the foliage may be scorched. In both cases the importance of employing only pure chemicals and good lime cannot be exaggerated, while the testing with the litmus paper should always be a feature of the preparation. When preparing the Bordeaux mixture lime of bad quality may cause trouble by choking up the nozzle of the spraying apparatus.

WHEN THE SPRAYING SHOULD BE CARRIED OUT.

It is well to strain the mixtures through a fine gauze before putting them into the spraying machines. The machines should be provided with nozzles that give a fine misty spray. It is important to have things adjusted so that the spray can be directed from below up to the foliage, as it will be remembered that the

largest number of spores are produced on the underside of the leaves. Spraying should, if possible, be carried out in dry weather in the early morning hours. The mixture will then stand a chance of drying on the leaves where it will remain to a considerable extent even if rain follows. Should heavy rain occur before the mixture has dried the spraying process will have to be repeated. As a rule, two to three applications will be needed for the crop in the season. The first should be given before there is the least sign of the disease. The date of starting the spraying will naturally vary in different districts. In the south of England, or in warm localities, some time during the first fortnight of June is to be recommended. In more northerly districts two or three weeks later will be soon enough. About three weeks later the second application should be made, whilst, after a similar interval, a third spraying is advisable in wet seasons. The mixture for the first application is to be at the rate of 100 gallons per acre, for the second and third sprayings quite 120 gallons per acre should be allowed. As is well known, spraying machines vary in size from a small arrangement that can be carried on the back up to a horse-drawn vehicle. (Fig. 2.) Where any difficulty in securing the use of a spraying machine is experienced it cannot be too widely known that application should be made to the Food Production Department, 72, Victoria Street, London, S.W.1.

POTATO SCAB (*Actinomyces scabies*).

Potato tubers are often rendered very unsightly by brown patches on the skin. These have been generally attributed to various causes such as mechanical injury or irritation from substances in the soil, but there is little doubt that in a large number of cases the underlying cause is the presence of the organism known as *Actinomyces scabies*. On a tuber that has been attacked by this minute organism, dark scabs are distributed over the surface of the skin, and, in some places, it would appear as if portions had been gnawed away. The scabs spread rapidly, and the appearance of the potatoes is rendered very unsightly, so much so that there is a decline in their commercial value. Potatoes badly covered with scabs are very apt to decay after storage. The disease is an extremely common one, more especially in small gardens and allotments, where potatoes have been repeatedly grown. Scab usually appears more often on tubers growing in land that has been liberally supplied with lime and other alkaline substances.

The disease may appear at any time during the growing period

of the tubers, though there is no danger of infection after the crop is lifted from the soil. The minute organism which causes the scab is believed to be present in almost all garden soil. It is even thought that, in the normal way, it plays a useful part in the decomposition of organic matter. First of all the scabs on infected potatoes appear as small brown spots, usually at the dark specks on the tubers, which are really the "breathing" places, or lenticels. The scabs increase in size and depth and when they have attained a fair dimension it is possible to feel the corky nature of the tissue formed by the tuber as the result of the irritating action of the organism. This formation has been well described as an attempt on the part of the potato to keep the organism from invading the interior of the tuber. That these defensive means are, in a measure successful, is shown by the fact that towards the end of the season the tissue falls away, leaving behind the familiar open scab.

FIGHTING POTATO SCAB.

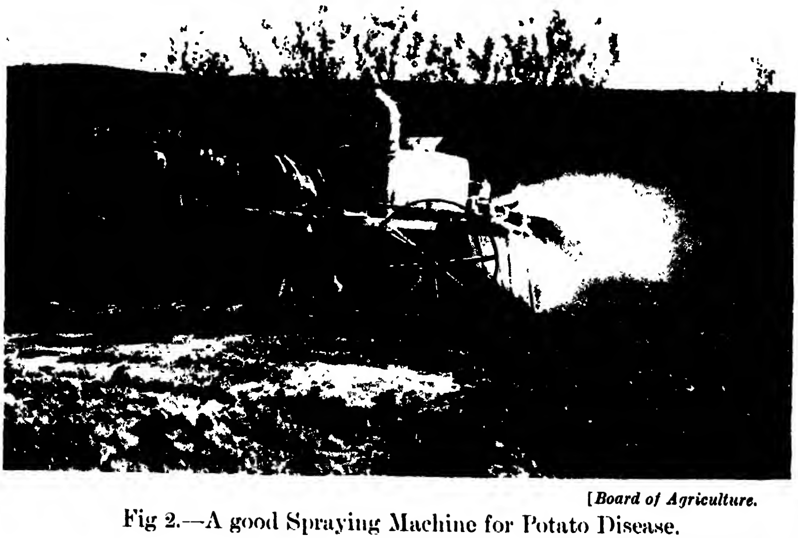
As has been indicated, the organism that is responsible for Potato Scab is present in almost all soil. It is only likely to be a nuisance where special conditions of the soil favour its activity. The old idea of sterilising "scabbed" tubers is not of much use.

The treatment of the soil where Potato Scab has been present is a matter of great importance. The organism flourishes chiefly in soil which is strongly alkaline, or where there is an abundance of humus. It is obvious that the use of lime, ashes, soot, or farmyard manure should be suspended where scab has been asserting itself. To correct an undue alkalinity of the soil superphosphate of lime and sulphate of ammonia may be used. Changes of crop rotation are also helpful. On land where the potatoes have been badly scabbed beetroot should on no account be planted, as this crop is very liable to be attacked by the same pest.

CORKY OR POWDERY SCAB (*Spongospora subterranea*).

The Corky Scab of potatoes is a very distinct disease from the last named, although in its early stages it is sometimes confounded with Potato Scab. The disease not infrequently occurs in such a mild form that little damage results. Although, when the circumstances are favourable, it will cause a considerable amount of injury. The tiny parasitic organism which is the cause of Corky Scab lives in the soil. It belongs to a singular group of organisms commonly known as the Slime Fungi, remarkable on

Fig 1. -Early signs of Potato Disease (*Phytophthora*).
1.—Black spots on Foliage. 2. The patches rot through in holes


[*Board of Agriculture.*
Fig 2.—A good Spraying Machine for Potato Disease.

[Board of Agriculture.

Fig. 3. - The result of spraying. The plants to the right were kept in a healthy condition although they were close to diseased specimens.

account of the fact that science has never been able to determine exactly whether they are plants or animals. The Spongospora is widely distributed in temporate regions all over the world, and, not long since, it was discovered in Peru, the original home of the potato. There seems little doubt but that the organism was introduced into Europe with the potato. Generally speaking the Corky Scab is confined to the moister parts of the United Kingdom. Hence it is found in its most severe form in Ireland, the west of Scotland, and Wales. In many of the drier British localities the disease hardly causes any trouble at all.

The first signs that a tuber has been attacked by Corky Scab are to be seen in small rounded swellings. These are no more than little lumps, and, quite often, the skin is not even broken. A microscopic examination of these swellings reveals the fact that they contain the Spongospora organisms. As time goes on, and the activities of the parasites increase, the skin surrounding the lumps becomes broken. At this time the parasite is ready for reproduction, a large number of tiny brown bodies known as sponge-like spore balls having been developed. With a lens these appear as so much brown dust, although each of these balls represents a number of spores clustered together. Before the lifting of the crop large numbers of these spore balls will have been liberated into the soil. The scabs from which the spore balls have been discharged are very different from the original swellings, seeing that they are quite open. A slightly scabbed potato is not seriously affected in value; little of the flesh of the tuber having been damaged. On the other hand, when Corky Scab appears in a severe form an effect is produced not unlike that of a cankerous nature. In such cases the potatoes are rendered quite useless, and where a crop has been heavily attacked the loss to the grower may be considerable. It has been discovered that in addition to its attacks on the tubers Spongospora is the cause of curious white galls on the fibrous roots of the potato. In appearance these are not unlike the bacterial tubercles present on the roots of leguminous plants. In themselves they do not appear to exercise a harmful effect on the potato plant, but when the reproductive phase is reached the dispersal of spore balls into the soil occurs and these are capable of infecting the tubers.

The manner in which the infection of tubers with Corky Scab comes about is interesting. It has been seen that the spore balls are at a certain stage in the development of the organism sent out into the soil. It is not quite certain how long these spore balls may remain dormant; probably nothing happens of any importance

until the coming of warm, moist weather in the following season. When favourable conditions arise each separate spore in the agglomeration will split up into a number of very minute spores (zoospores) which are extremely active. Prodigious numbers of these zoospores swarm away through the soil, and if there should be a potato crop in the ground a big proportion of them are certain to come up against the young growing tubers. Their attacks will be responsible for the rounded lumps which have already been mentioned as the early sign of the Corky Scab disease.

HOW CORKY SCAB IS SPREAD ABOUT.

The chief means by which Corky Scab is distributed is through the planting of infected tubers. The tubers apparently may be quite sound, but the fact that they have been grown in soil where the organisms are present, or have been in contact with diseased tubers, cause them to be " carriers." The spore-balls may adhere to tools or human clothing and in this way be distributed from one locality to another. That they retain their vitality for a considerable time has been proved beyond question.

THE CONTROL AND PREVENTION OF CORKY SCAB.

If possible potatoes affected even slightly with this, or any other kind of scab, should never be used for seed, and where it is known that land is contaminated other crops should be sown in place of potatoes. This course may not always be feasible seeing that the spores in some form or another appear to retain their vitality for four or five years, and perhaps even longer. Thus we are faced with the problem that many growers may have to use " seed " that is infected and may not be able to avoid the planting of a potato crop on ground that is contaminated. Happily, treatment that will help in fighting the disease is possible for both the " seed " and the soil. With regard to the disinfection of the " seed " various plans have been indicated. Scabbed tubers soaked for eighteen or twenty-four hours in a 2 per cent. Bordeaux mixture gave a healthy crop. This plan, however, tends to reduce the yield of the crop and is not a very satisfactory method. It is better to soak infected tubers in a formalin solution or moisten them and roll them about for a moment or so in flowers of sulphur. Where the " seed " has been treated in this way a perfectly healthy crop will result providing the ground is not infected. It may be a difficult

matter completely to disinfect land which is contaminated with the Spongospora. Dressings of lime make matters worse and the disease is most active of all where there is an excess of lime in the soil. Probably the best results have been secured by dressings of flowers of sulphur, whilst anything to improve the drainage of the land should be carried out.

WART DISEASE OR BLACK SCAB (*Synchytrium endobioticum*).

This disease has been described under such various names as Black Scab, Wart Disease, Potato Canker, etc. A diseased tuber is at once recognised by the curious tumours at one or more points. These usually appear in the first place at the " eyes " of the potato, and, as a rule are more common at the toe or crown end of the tuber. As they develop the warts become much wrinkled and a spongy mass is often formed by several of the outgrowths running together. The trouble is not by any means confined to the tubers for the warts are often found at the collar of the haulm either just above or below the surface of the soil. The underground parts of the stem and even the fibrous roots may also be affected. Generally speaking it is the tubers which lie nearest to the surface that are most badly attacked. It has been observed that plants which may be very badly diseased with the Synchytrium show small signs of the trouble whilst growing. The foliage appears to be healthy and frequently remains green for a longer period than that of unaffected specimens. Where the disease has reached an advanced stage the affected parts start to decay with a wet rot, and the tubers are rendered useless.

The Synchytrium is a member of a low group of fungi, the Chytridiaceæ, which are connected in many ways with the Slime Fungi already mentioned. The Chytridiaceæ are interesting on account of the fact that they are generally regarded as the originating group of fungi in general. That the Synchytrium is a very low form of fungoid life is shown by the fact that, in its early stages, there is no trace of a mycelium; the plant is a simple mass of living matter in the cells of the potato. The growth of this parasite irritates the tissue of the tuber, or whatever part of the plant the Wart Disease has attacked. During the warm weather the Synchytrium is spread through the agency of spores which release active zoospores into the soil. For the winter season a special resting spore is developed. These resting spores are enclosed in a hard case and, when the tubers in which they have been evolved decay, are loosed into the soil. Here they may remain as resting spores or in

some other stage for an indefinite time. How long vitality may be retained has not been definitely established, although there is good reason for believing that in favourable conditions they may start a more active career after at least five years. When they do germinate, the resting spores give rise to zoospores which are able to infect fresh potato plants.

A singular feature of the Wart Disease is its comparatively limited distribution. For some reason which is not at all clear the trouble is almost exclusively confined to the industrial districts of England and Wales. In agricultural districts the Wart Disease is extremely rare. According to the Board of Agriculture the disease is known to exist in its greatest intensity in the neighbourhood of Manchester and Birmingham, and is very common in the mining towns and villages of South Lancashire, Staffordshire, Glamorgan, Derbyshire, and West Nottinghamshire. It has also been discovered in the manufacturing districts of Cheshire, North Worcestershire, the West Riding of Yorkshire, amongst the quarries of Cumberland, Carnarvonshire, and Leicestershire, and in the neighbourhood of London, Swindon, Bristol and Lincoln. Even where the disease is very prevalent the number of farms attacked is not usually large, although where it does occur the disease may be in a very intense form.

HOW WART DISEASE IS DISTRIBUTED.

The manner in which the Wart Disease is distributed is worth some consideration. It has been proved that the spores of the Synchytrium may be carried about in the soil by the natural drainage of water. Naturally the movement is to the lower level and progress is slow. It has been shown that, on level ground, the normal rate at which the disease travels is about nine inches a year. Where the ground has a marked downward tendency the progress would be accelerated, but it would rarely be more than a couple of feet in a year. In the past the Wart Disease has been freely spread by means of infected potato plants and tubers. Happily, it is now compulsory, under a penalty, to burn the haulms and root parts of all plants that are known to be infected. It is not even safe to use the diseased tubers for the feeding of live stock seeing that the spores pass uninjured through the animals and, when they reach the soil, are ready for growth. Infected soil clinging to boots, tools, etc., might carry the disease from one place to another.

FIGHTING THE WART DISEASE.

A very large number of experiments have been carried out with a view to checking the ravages of the Wart Disease. Lime, sulphur, soot, sulphate of copper and formalin (to mention only a few substances) have been tried without success. Digging the ground three spits deep and placing the top layer at the bottom seemed to have no effect in preventing the disease. Fortunately, certain varieties of potatoes have, after very severe tests, shown themselves to be quite immune to the Wart Disease, and in districts where the soil is known to be infected these kinds alone should be used. A selection by the Board of Agriculture of the best immune varieties is as follows:

EARLY VARIETIES ..	Conquest, King George, Great Scot.
LATE VARIETIES ..	Abundance, Admiral, Langworthy and St. Malo Kidney.

It has been shown that the Wart Disease is able to attack some plants allied to the potato. The Woody Nightshade (*Solanum dulcamara*) and the Black Nightshade (*Solanum nigrum*) have both been observed with Wart Disease infection. Where the disease has appeared it is a wise plan to root up and destroy any specimens of these weeds.

RHIZOCTONIA SCAB.

This fungoid pest is to be found in almost every part of Ireland. The external evidence of the disease is a web-like coating of the fungal threads spreading over the skin of the tuber, but especially to be noticed about the "eyes." Here and there are to be observed reddish-brown bodies of a spongy texture. These are the resting bodies of the organism similar to processes found in other kinds of fungi. The scientific name of these bodies is sclerotia. In the case of Rhizoctonia the sclerotia stand out quite prominently, and, although the tuber is rendered unsightly, it is not seriously harmed so far as its internal parts are concerned. Should the skin of the potato be damaged the fungal threads of the Rhizoctonia enter the tuber and thrust their way in and out amongst the cells. The flesh of the potato then becomes soft and watery, finally rotting. Very little is known as to the life history of the Rhizoctonia. It has been proved that the use of "seed" infected with this fungus results in a diseased crop. Experiments have been tried in which infected tubers have been soaked in weak solution of corrosive sublimate or formalin. In some instances this has seemed to check the spread of the disease.

PHELLOMYCES SCAB.

This is another fungoid disease that has a wide distribution in Ireland. An affected tuber is seen to be covered with numbers of small black specks. A microscopical examination shows these to be minute sclerotia. At this point the Phellomyces does not do much harm to the tuber. Later on it will be likely to give rise to a scab formation, though recent work suggests it is a relatively harmless pest. At this stage the skin of the potato is covered with patches which are whitish or light brown, according to the period over which the attack has been proceeding. These patches tend to link up together, and, at last, parts of the tubers are robbed of the protection afforded by the skin owing to their peeling. When the skin peels off it often carries with it sclerotia which at some subsequent date are capable of infecting other tubers. With the departure of the skin the threads of the fungus can penetrate deeply into the attacked potato, where it starts a dry rot. In an advanced state the tuber becomes dry and powdery, a condition which is reached after the tubers have been stored away. Sclerotia are often to be found in the inner substance of the tuber when the disease has secured a strong hold. The Phellomyces is most common in damp ill-drained soils. Indeed, it is rare on light, well cultivated land. That the ground is often badly infected has been proved by the fact that on the "seed" of several varieties from France (where the disease was unknown) being planted in a district in Connemara, the crop was badly attacked by Phellomyces. Apart from this not a great deal is known as to the life history of this particular form of scab disease. Tubers that have shown signs of infection have been treated with a weak solution of formalin and then used for "seed." The resulting crop was quite free from disease, although a control plot where the "seed" was untreated showed the presence of Phellomyces on the tubers. Prof. Johnson, of the Royal College of Science, Dublin, considers that the soaking of all seed tubers in a weak solution of formalin might always be followed with advantage, in the wetter parts of Ireland especially.

THE STALK DISEASE (*Sclerotinia sclerotiorum*).

Apart from the Potato Disease (*Phytophthora infestans*) the stalk disease of the potato is the most serious of all the pests attacking this important crop. The fungus causing this trouble is closely related to that which is responsible for the well-known clover sickness—*S. trifoliorum.* Like almost all potato diseases, the stalk disease gives most trouble in the damper parts of the

country. For instance, it is particularly harmful in the West of Ireland and also in some of the north-western counties of England. The point of attack is the stem; sometimes quite close to the ground, on other occasions some distance above it. The tubers are not directly affected but their growth and development are hampered to a very serious extent owing to the stem being attacked. As the stalk disease progresses it destroys the tissues of the stem to such an extent that it falls over at the point of attack and the foliage which it bears dies.

LIFE HISTORY OF THE STALK DISEASE.

As a rule the Stalk Disease does not put in an appearance until after Midsummer. About this time certain parts of the stem are covered with a dense white coating; this is formed of the threads of the mycelium of the fungus. At this stage there is little change in the appearance of the foliage. If the weather is damp and close the disease progresses rapidly. Numbers of little rounded cushions are formed by the mycelia. These at first are white in colour, but as time goes on they become black and hard. These processes are the resting bodies (sclerotia) of the Sclerotinia, and they are not infrequently the size of a pea, though they are rarely so perfectly rounded. Towards the end of the summer the sclerotia fall off and will then lie in the soil in a dormant condition until the Spring. When the warm weather comes again they germinate and give rise to pretty little cup-shaped bodies borne on slender stalks. These appear just above the surface of the soil, and within the cup are produced the spores. It may be mentioned in passing that this cup, technically an apothecium, is characteristic of one of the great groups of fungi known as Discomycetes, where the spore-bearing surface is generally saucer-shaped and fully exposed. When the spores are ripe they are discharged into the air. Those that alight on any potato foliage stand a good chance of further development, especially if the leaves on which they rest are showing any signs of decay. The spores quickly germinate and the leaves are affected, but the fungus soon passes into the stem. Sometimes the stem is directly attacked, especially if the spores have settled in such places as the leaf axils, where there is likely to be moisture. It has been proved beyond question that the infection of potato plants by the Sclerotinia can only take place by means of the spores. At one time it was thought that the plants were assailed by the vegetative mycelium present in the soil, but this is not the case. The Sclerotia attack a large number of garden plants, such as tomato, artichoke, bean, marrow, cucumber, carrot and turnip.

FIGHTING THE STALK DISEASE.

No good results have attended the spraying of the plants in the case of stalk disease, and up to the present it does not seem possible to treat infected soil with any hope of success, except by sterilisation with heat, a plan only suitable for garden or glasshouse work. Where ground is known to be infected by Sclerotinia the best plan is to avoid growing potatoes, or any other crop liable to be attacked, for at least three years. No plants, save those which are known to be immune should be cultivated anywhere near to the danger area. Where the disease has appeared every part of the plant that is affected should be burned. If this is done systematically through the season a check is put upon the spreading of the fungus.

BOTRYTIS DISEASE (*Botrytis cinereo*).

This parasitic fungus sometimes causes a great deal of harm to potato crops. The attacks are exclusively confined to the haulms and there is no tuber infection known as yet. The Botrytis Disease is most noticeable in the late summer when dying potato stems are seen to be thickly covered with small black bodies. These are the sclerotia, by means of which the Botrytis fungus will get over the winter season. With the return of warm weather in the spring the dispersal of spores from the sclerotia takes place. The spores usually germinate on damaged leaves, though when the season is very damp they may attack quite healthy foliage. In any case the first signs of the disease are noticeable on account of certain dead areas near to the borders of the leaves. As the mycelium of the Botrytis extends, it spreads through the tissues of the leaf stalk and finally reaches the stem, killing the outer tissue and consequently the leaves, which may drop off in large numbers. The Botrytis disease may develop rapidly and in a severe form during damp, close weather, so that the whole shoot of a potato plant may die. Finally, a grey mould is seen to be spreading over the dead leaves, and this will be the fruiting body of the Botrytis fungus. Huge numbers of spores are produced, and these are dispersed in all directions by the wind, or they may travel in drops of water. Should they settle on any potato foliage they are capable of setting up a fresh centre of infection. Finally, as has been indicated, the fungus passes into its winter stage with the formation of sclerotia. A curious point about the Botrytis fungus is that whilst under suitable conditions it is truly parasitic (that is it exists on living matter) yet this is only one phase of its life. Often, especially after the dispersal of spores in the spring, the

mycelium lives on decaying vegetable matter, in which case it is called a saprophyte—that is an organism existing on dead material. Another curious point in connection with the Botrytis fungus is that its attacks are not confined to the potato and its allies. A very large number of species in distinct families are now and again attacked. Thus the Botrytis fungus is responsible for the leaf shedding well known in the case of conifers.

Spraying with various solutions has been tried where the Botrytis disease has appeared, but hitherto without any very satisfactory results. As a rule varieties of the potato that resist the *Phytophthora* are not seriously attacked by the Botrytis fungus. Where the disease is prevalent it is wise to select the kinds that are known to be immune. The chances of infection during the next season will be much lessened if all the dead and dying parts of the potato plants are gathered up and burned before the crop is lifted.

BLACK LEG OR BLACK STEM ROT (*Bacillus phytophthorus*).

The Black Stem Rot disease of potatoes has a very wide distribution wherever potatoes are cultivated. There has been a good deal of difference of opinion as to whether the trouble is always caused by one species of bacillus. Whether this is so or not, the effects are almost identical in all cases, and it is convenient to regard the disease as due to the attacks of one organism. Black Leg is early in putting in its appearance on the potato plants seeing that quite often it may be found by the middle of June. As a rule, it is easy to distinguish the affected plants on account of their yellowish foliage and generally stunted appearance. There is also a tendency for the margins of the leaves to roll inwards. But it is at the base of the stem that the disease can be seen most plainly. A stem that is badly-attacked will come away quite easily when it is pulled because at the base it is rotten. Sometimes every stalk is affected, whilst in other cases the trouble is confined to one or two. If a stalk is cut through it will be found that even the pith is black. If a transverse section is cut through an affected stem it will be noticed that there are three brown spots. These are the woody parts of the chief vascular bundles, and their brown colour is due to the activities of the bacteria. When these vascular bundles are examined under the microscope they are found to be swarming with the bacteria.

HOW BLACK LEG FINALLY AFFECTS THE POTATO PLANTS.

Towards the later months of the season the potato plants that have been attacked by Black Leg show some striking changes. The

foliage turns brown and often the stalks die off altogether. Where the disease has secured a very early start the plants may be almost dead before anything in the way of tuber formation takes place. Where the trouble has been late in starting, or for some reason has made very slow progress, new tubers will have been developed. These will have been attacked by the bacilli which pass along the underground stems to their swollen ends, which are, in fact, the potato tubers. The diseased tubers can be at once recognised as they are much discoloured and very likely quite soft, particularly at that part which is nearest to the stem. In any plant where the disease is making itself fully felt all the tubers may finally rot. These rotten potatoes may affect healthy tubers with which they come in contact—in store, for instance. Each diseased example contains countless millions of the bacteria capable of spreading the rotting trouble.

PRECAUTIONS AGAINST BLACK LEG.

Where the land is free from infection diseased "seed" is the cause of Black Leg. Tubers that appear to be quite sound are often infected and the chances are that these will produce diseased plants. "Seed" from plants that have suffered from black leg even to the smallest extent should never be used. It is an excellent plan to dig up all specimens that show signs of Black Leg, taking care to remove every tuber from the soil. If the potatoes are of fair size they may be used for culinary purposes at once ; the rest should be burnt. No part of the produce should ever be stored away. As far as experiments in the United Kingdom have shown there is no clear evidence that land which has borne a diseased crop is certain to infect healthy "seed." But, seeing that the soil will contain the bacteria, infection seems highly probable. It is a wise plan, therefore, not to plant potatoes in such soil until at least a year has elapsed since the removal of a diseased crop.

X.—ANNUAL REPORT UPON THE SOCIETY'S GENERAL OPERATIONS.

By Thos. F. Plowman, Secretary and Editor.

The Society having been prevented holding a Show in 1917, the Annual General Meeting of Members, which, under ordinary circumstances, is held in the Showyard, took place on Thursday, October 25th, in the G.W.R. Board Room, Bristol.

In the unavoidable absence of the President (the Earl of Coventry), the Marquess of Bath, K.G., Vice-President, was voted to the Chair, and there were also present Lord Strachie, Sir J. Shelley, Bart., Messrs. C. L. F. Edwards and R. Neville Grenville, Vice-Presidents; Colonel H. Lewis, Messrs. J. E. Daw, H. Gibbons, J. T. Gibson, J. Cooke Hurle, G. Lipscomb, C. M. F. Luttrell, G. Martyn, F. F. Mason, M. St. J. Maule, H. B. Napier, W. Nixon, John Williams, Thos. F. Plowman, Secretary and Editor; etc.

Communications from members regretting inability to be present, in many cases owing to Military duties, were read.

The Chairman moved, Sir J. Shelley seconded, and it was resolved, that Mr. A. O. Sillifant be elected a Vice-President of the Society in recognition of his long and valuable services to the Society.

On the motion of Mr. W. Nixon, seconded by Mr. H. Gibbons, the gentlemen named on page *viii* of the Appendix to this volume, were elected Members of Council for the years 1917–19.

The accompanying Report, which had been adopted at a meeting of the Council held that day, was then submitted to the meeting:—

"The Council regret that they had again to present their Annual Report to the Members under circumstances, arising out of the conflict the Nation is engaged in, which have materially interfered with the carrying on of the Society's ordinary operations. They can only fervently hope that the time may not be far distant when an honourable and a permanent peace may remove the disabilities under which the Society, in conjunction with all similar institutions, is suffering and thus enable it to bring all its old activities to bear in the cause to which it has so long devoted itself.

Although, in view of the necessary restrictions imposed by the War, it has been impossible to hold a Show during the present year, the Society's organisation has been maintained in a state of readiness to take advantage of the earliest opportunity of renewing this important feature of the Society's work, and the Council will continue to keep a watchful eye upon any developments of the national situation likely to render them free to take action. Meanwhile, they

would welcome any suggestions from Members with regard to cities or towns which the Society could opportunely visit as soon as the present limitations are removed.

The Council desire to express the Society's indebtedness to Lord Coventry for kindly consenting to continue to act as President until such time as the Society is in a position to decide upon its future action with respect to a Show.

The Society's Show Plant is still being housed on the site of the Worcester Show, and the Council are indebted to Mrs. Kirkham for so courteously permitting this.

Since the last Annual Meeting, the Council have lost by death an old and valued colleague in the person of Mr. George Gibbons, a Vice-President and Senior Dairy Steward, in which latter capacity especially he had for many years rendered devoted service to the Society. A full reference to his work for the Society as well as for Agriculture generally appears in the current issue of the Society's Annual Journal. Death has also deprived the Society of many other old and valued supporters, among whom were: The Earl of Mount Edgcumbe and Lord Fitzhardinge (Vice-Presidents), Lord St. Audries, Lord Lucas, Sir M. Fitzgerald, Admiral the Hon. T. S. Brand and Colonel R. Chester-Master.

Extraordinary vacancies in the Without Reference to District Division of the Council have been filled up by the election of Mr. John Williams, of Scorrier House, Scorrier, Cornwall, and the Right Hon. F. Dyke Acland, M.P., of 93, Bedford Gardens, Campden Hill, London, W.

The Council recommend that, in recognition of his long and valuable services to the Society, Mr. A. O. Sillifant be elected a Vice-President, that the gentlemen named on the Agenda Paper of the General Meeting, being all retiring members willing to serve again, be re-elected Members of Council for the years 1917–1919, and that the Earl of Morley and Mr. A. Masters be elected to vacancies in the Western and Without Reference to District Divisions of the Council.

The Council have acceded to the request of the Committee of the Sugar Beet Growers' Society and of the Dairy Research Committee of University College, Reading, that they would appoint representatives of the Society upon those bodies, by appointing Mr. H. Alexander upon the former and Mr. T. Latham upon the latter body, both gentlemen having expressed their willingness to accept nomination.

In view of the dearth of good milkers, the Council have formulated a scheme under which a sum of £200 has been allocated for the

promotion of instruction in Milking and for rewarding proficiency in its practice. In accordance with this, grants are being made to such Agricultural Instruction Committees of County Councils within the area of the Society's operations as are prepared to co-operate with the Society in facilitating the objects in question. The scheme has been very favourably received by Counties included in it, and the Council confidently hope that the result will stimulate the supply of Milkers and be an encouragement to proficiency in this important branch of Agricultural work.

The Council have continued the Annual grant of £100 to the National Fruit and Cider Institute in the full belief of the value of its work. The Institute—the establishment of which was due to the practical and scientific research work initiated at Butleigh by Mr. R. Neville Grenville and conducted for some years (1893–1903) conjointly by the Society and the Board of Agriculture, under the direction of Mr. F. J. Lloyd, F.C.S.—is now attached to Bristol University. Experimental and research work is being actively carried on at the Institute, which there is every reason to believe is of essential service to those engaged in cider-making and fruit-growing. An arrangement has been made under which members of the Society can obtain from the Institute, free of charge, analyses of cider apples and perry pears.

The Institute has also undertaken to distribute to the Society, or to persons nominated by it, free of charge, a selection of trees which have been worked with the best varieties of cider apples and perry pears, and has conferred upon the Society the privilege of nominating, free of all fees, one student for a course of instruction in the theory and practice of fruit-growing, cider-making, etc., to be held by the Institute at the University of Bristol.

With a view to assisting farmers and others in dealing with insect and other pests which affect agriculture, horticulture, etc., the Council have availed themselves of an offer from the Board of Economic Biology of the University of Bristol to investigate the nature of any insect or other pest and report upon it free of charge.

A copy of the Society's Annual Journal for the current year has been forwarded to all Members not in arrear with their Subscriptions, and the Council have every reason to believe, from communications which have reached them, that such a record of the Society's work as well as of the leading agricultural topics of the time is appreciated by the Members and by the agricultural world at large.

The Council desire to acknowledge the generous manner in which the Members have supported the Society during the past year, and earnestly urge upon them and all who have the welfare of agriculture

at heart the necessity of a continuance of this support, as it seems abundantly clear that, on the conclusion of the War, such help as agricultural organisations can render will be more than ever needed. In order to enable the Society to resume its full services in this respect, it is incumbent upon it to maintain its organisation intact so that it may be in a position to deal at once with such problems as may arise upon the much-desired advent of an enduring peace."

The Chairman, in moving the adoption of the Report and its publication in the Society's Journal, desired, on behalf of the Meeting, to congratulate the Secretary upon his admirable report, which showed how intimate a knowledge he had of the Society's work and possibilities. The Marquess, after referring to the chief subjects of the Report, dwelt upon the vital necessity of the Society maintaining its organization intact, and of a continuance of that generous support which its members had hitherto accorded it. Apart from the work which would need all the help the Society could give after the War, it was very necessary that such organizations should be at hand to protect the interests of agriculture, in view of the operation of the Redistribution Bill. He referred to it in no political sense, but the effect of the Bill by the re-arrangements proposed, was to greatly reduce the voting power and influence of the purely agricultural electors, whose interests would need all the protection that representative Societies could bring to bear.

Sir J. Shelley seconded the motion, which was supported by Mr. Mason, who referred to the gratifying circumstance that, notwithstanding the many claims of war-time, the members had well backed up the Society; and by Mr. R. Neville Grenville, who said that so long as the members had so excellent a Journal as the one for the current year, they would get a good *quid pro quo* for their subscriptions. The motion was then put and carried unanimously.

XII.—THE NATIONAL FRUIT AND CIDER INSTITUTE.

By B. T. P. Barker, M.A., Director.

The prolongation of the war and the consequent need for the concentration of all effort on work of immediate national importance have, to a rapidly increasing extent, had a marked effect upon the activities of the Institute. The reduction of the scientific staff by the continued absence of Mr. C. T. Gimingham, the Chemist of the Station, who is engaged on special work in the Anti-Gas Department of the Army, and the internment of Dr. Lechmere in Germany, the

very considerable call upon the time of the remaining members of the staff made by the various schemes of the Food Production Department of the Board of Agriculture with which the Institute has been concerned, and the constantly increasing labour difficulties have combined to reduce the ordinary research and experimental work very materially. The greatest difficulty has been experienced in carrying out the necessary cultural operations in the fruit plantations and the development of new experimental work there has almost entirely ceased. In the cases of investigations already in progress, where it has been possible to suspend operations for the time being without any further serious detriment than loss of time, this has been done. At the request of the Board of Agriculture the land has been utilised to the maximum degree possible for food production, potatoes and various vegetable crops having been raised by intercropping on all available land. A tribute is due to Mr. H. Locke, the fruit foreman, for the results which he has achieved in spite of severe handicaps in every direction.

There have been no staff changes to note during the year, the temporary arrangements for conducting the various branches of work recorded in the last Annual Report having been continued. All members of the staff have been associated with one or more of the various new schemes concerned with food production or preservation initiated by the Food Production Department, and the opportunities of proceeding with investigations of the usual order on fruit culture, plant diseases and their treatment, and on cider-making have accordingly been limited. The services of the Director have been lent to that Department at its request, and he has been associated with the work of the Horticulture Division of that body since last May, assisting in its general technical work and also in the organisation of the schemes for the preservation of the 1917 fruit crop. The latter work has now been mainly taken over by the Ministry of Food, and the resources of the Institute have been placed at its disposal and are being freely utilised. Mr. Grove, Mr. Spinks and Mr. Camps have been actively concerned with the schemes for making jelly from cider fruit and the utilisation of apple pomace referred to in detail in this report, and Mr. West has acted as manager of the jelly-making centre established at Long Ashton. Mr. Lees, in conjunction with the Director, undertook the general organisation of the potato-spraying scheme of the Food Production Department for the area included in the Bristol Province, viz., Gloucestershire, Herefordshire, Somerset, Wiltshire and Worcestershire, and devoted the greater part of the summer to rendering assistance to the various local organisations as required. In Long Ashton and district the

Institute undertook the spraying of the potato crop for growers, where desired, on the lines of the scheme developed by Mr. Gimingham in 1916, Mr. Spinks being responsible for the arrangements in this case. Mr. Spinks also undertook an enquiry into the supplies of local labour for collecting the apple crop in the West of England, and at the same time organised in the cider-making districts a scheme for ensuring, by drying, the preservation of the supplies of pressed apple pomace not required as cattle food in the fresh state. Mr. West and the Director have assisted in Long Ashton and district in the survey of grass land undertaken by the Somerset War Agricultural Committee for the purpose of bringing more land under the plough. In addition to these calls on the time of the staff, numerous miscellaneous questions concerned with food production and preservation have received attention, while Mr. Gimingham's absence has thrown a greater burden of advisory work on the remaining members of the staff.

During the year a matter of the utmost importance affecting the future of the Institute has arisen. On its establishment in 1903, 15 acres of land situated in the centre of Fennswood Farm, Long Ashton, were leased from the Ashton Court Estate for the purposes of experimental work in fruit culture and related subjects. At the time of the association of the Institute with Bristol University 10 acres of this land, on a part of which the permanent buildings have been erected, were purchased; and small amounts of additional land have from time to time been leased until, at the beginning of 1917, a total area of 28½ acres had been acquired. Practically the whole of this is now planted up with fruit of various kinds. After the conclusion of the war, when it is again possible to proceed with field trials and experiments, a considerable additional acreage will be required. Since Fennswood Farm will be vacated by the present tenants in March, 1918, and since any fresh land acquired must be taken from that farm if it is to adjoin the existing plantations, it has been necessary to consider carefully the question of the future development of the station and its probable needs. As a result an arrangement has been arrived at between Bristol University and the Ashton Court Estate by which the whole farm of 250 acres may be ultimately purchased, if desired, and, in the meantime, provision has been made to take over sufficient land to meet more immediate requirements. The sanction of the Board of Agriculture and the Development Commissioners for this course has been obtained and the Institute will shortly, therefore, have at its disposal for research in fruit culture a total of 53 acres, which should suffice for necessary developments for a few years.

By arrangement with the County Councils of Gloucester and Somerset a series of courses, each of a month's duration, for training girls in the elements of market gardening, was held at the Institute from May to August last. In all 36 students attended the courses and subsequently engaged in work on the land. Their work generally at the Institute was highly satisfactory, and many of them should develop into efficient substitutes for male labour in market gardens and on fruit farms. A portion of the laboratory building was given up to provide for their accommodation, since suitable facilities in the neighbourhood could not be found. Mrs. Stock very kindly gave her services as matron for the greater part of the season, Miss Hartley acting in that capacity for the first few weeks. To these ladies hearty thanks are due, the success of the courses being largely contributed to by the excellent manner in which the welfare of the girls was studied by them in every possible way.

For the remainder of the war courses of training in fruit culture for partially disabled officers intending in due course to take up fruit farming are now being arranged at the request of the Board of Agriculture and the Ministry of Pensions. Consequently the girls' courses will be discontinued during the coming year. The training of the officers will extend over a period of two years, the first being spent at Long Ashton, where instruction in the methods of practical fruit culture and in the sciences of chemistry, botany and zoology in relation to that subject will be given, and the second on suitable fruit farms where the commercial side of fruit-growing will be more particularly dealt with. The first course will start in February, 1918.

The following sections of this Report are concerned with some of the various problems which have been under investigation during the year, and also with work which has been undertaken on behalf of the Food Production Department. No reference is made to several investigations in progress which are still in too incomplete a condition to report upon, or to a number of miscellaneous enquiries concerned with problems of immediate urgency which it is not desirable to specify at the present moment.

The individual sections of the Report have been contributed as follows :—

Single Variety Ciders and Perry, 1916–17 : by O. Grove.
A Ropy Cider Bacillus : by O. Grove.
A Note on Cider Vinegar : by O. Grove.
Notes on the Fruit Blossom Bacillus : by O. Grove.

Damping-off and Collar Rot of Tomatoes: by G. T. Spinks.
Further notes on the Treatment of a *Rhizoctonia* Disease of Asparagus: by B. T. P. Barker and C. T. Gimingham.
"Reversion" of Black Currants: by A. H. Lees.
The Raspberry and Loganberry Beetle, *Byturus tomentosus*: by A. H. Lees.
Further Experiments on Big Bud Mite: by A. H. Lees.
Copper Stearate: by A. H. Lees.
Investigations on Apple Stocks: by B. T. P. Barker and G. T. Spinks.
The Manufacture of Cider Apple Jelly on a Commercial Scale: by B. T. P. Barker.
The Utilisation of Cider and Perry Fruit under War Conditions: by B. T. P. Barker.
Potato Variety Trials with Selected Seed: by B. T. P. Barker.

INVESTIGATIONS ON CIDER.

Single Variety Ciders and Perries, 1916–17.

In the table given below will be found a list of the ciders and perries made during the season 1916–17, with details as to chemical composition and other particulars. The usual notes upon the character of the individual samples are omitted this year.

The average specific gravity of the juices was 1·0514, which is about the normal. The highest specific gravity obtained was 1·059 from Kingston Black, No. 14 in the table, the lowest being 1·044 from Red Cap, No. 5. Taken generally the quality of the ciders was about normal, the majority fairly good with a few very good ones; upon the whole they have kept better than usual, all the samples being in perfect condition after having been kept in bottles for about 12 months. A special feature of this season was a peculiar, not unpleasant, ether-like taste found in many of the samples, this being especially remarkable in Nos. 41 and 43. This might be due to the very cold fermentation temperature during the unusually severe winter. The low temperature would tend to keep the ethers developed during fermentation more in solution than usual. By distilling samples at 60°–70°C. it was found that a certain amount of fruity ethers could be separated.

Sharp Varieties.—In this group the three first were fairly good ciders, somewhat thin and unripe in flavour, but they all improved by keeping. No. 4 was a pleasant, medium brisk cider of quite good quality, better than No. 5, which was rather thin. No. 6 and, especially, No. 7 were very good ciders, the last being particularly

fruity and brisk, well adapted for bottling purposes. No. 8 and 9 were good ciders, No. 8 being of good body and fairly sweet. No. 9 was rather thin and very sharp. No. 10 was a very good sharp cider, very suitable for blending with sweet or bittersweet types. Of the Kingston Blacks No. 16 was the best, Nos. 12, 13 and 15 being fairly good samples. Nos. 11 and 14 were rather inferior for the variety.

Sweet Varieties.—The Sweet Alfords were exceptionally good this season, No. 20 especially being very good indeed. The next in merit was No. 19. Of the other sweet ciders No. 21 was fairly good, full-bodied, but lacking in fruity character. No. 22, which was tried for the first time, was a very good, full-bodied type. No. 23 had a rather crude flavour, but No. 24 was very good with a well-pronounced aroma.

Bitter-sweet Varieties.—No. 25 was dry and bitter, No. 26 fairly good, medium-sweet with a rather bitter after-taste. Nos. 27 and 24 were much alike, good, sound ciders with marked tannin flavour. Nos. 29, 30 and 31 were quite good ciders of moderate body. No. 32 was fairly good, but very bitter; No. 33 fairly good, but lacking in body, and No. 34 was a good cider, very soft with good aroma. The same can be said of No. 35. No. 36 was fairly good; No. 37 very good, but a little thin; and No. 38 of medium quality with a peculiar flavour of straw. No. 39 was good and No. 40 a very good cider with a clean bitter flavour. Nos. 41–43 were fairly good with a peculiar ethery flavour.

The only perry made, No. 44, was very good, although not quite brisk enough.

Ciders made from Mixed Fruit.—The samples No. 45*a* to 54*c* were all made from mixed fruit and treated in different ways. No. 45*a*, the unfiltered sample, was a very hard and unpleasant type; *b* was very similar, but *c* was fairly good. As this mixture was of the quick fermenting type, the racking did not have any effect; only by filtration was it possible so to check fermentation that a fairly good medium sweet cider was obtained. Nos. 46*a* and 46*b* were both quite nice ciders, mild and a little thin, the filtered sample perhaps a little superior to the racked one; they have both kept well and, as this mixture was of the slow fermenting variety, the racking was quite efficient. No. 46*c*, where the juice had been pasteurized and pure yeast added, showed a very slow fermentation and was not filtered until six months after it had been made. The cider had a good clean flavour, but was too sweet; it had kept very well. Nos. 47*a*, *b* and *c* show very markedly the influence of racking and filtering. Sample *a*, which had been left

in the cask without filtering or racking, was decidedly inferior to *b* and *c*. In the case of No. 48 the filtered sample was superior to the racked one. The same can be said of No. 49, although the two other samples were quite good. No. 50*a* was very inferior; 50*b* was not good, but better than *a*; *c* and *d* were fairly good ciders, *d* having a cleaner flavour than *c*. No. 51*a* was fairly good, but thin, and 51*b* very similar. No. 51*c* was quite good, sweeter than the preceding. No. 51*d* fermented very slowly; it was similar in flavour to *c* with a trace of cooked taste. No. 52*a* was sharp and rather unpleasant, 52*b* was a good deal better and 52*c* quite good. No. 53*a* was fairly good, and 53*b* similar but decidedly superior. Of Nos. 54*a*, *b* and *c*, *a* was the best of the three, *b* being fairly good and *c* inferior to the other two.

A Ropy Cider Bacillus.

During the summer some samples of ropy cider were sent in for examination from the Tewkesbury district. The cider was slightly cloudy when received, and this cloudiness increased greatly until, after being kept for about six months, the liquid was nearly milky with a stringy deposit. This deposit consisted principally of different kinds of bacteria, of which the predominating types were a small rod bacillus and acetic bacteria. The usual yeast cells and Torulas were present in smaller quantity than in normal ciders. When the bottles were shaken the deposit formed strings in the liquid, which poured like oil. The aroma of the cider was of a pronounced acetic character, and the flavour acetic and peculiar. The specific gravity was 1.001; the acid (determined as malic acid) ·90 per cent.; tannin ·08 per cent.; and alcohol 4·02 per cent. by weight.

A number of organisms capable of producing ropiness in cider have been recently described by Kayser. These were isolated from various French ciders. Hitherto no satisfactory case of any organisms producing ropiness and occurring in English ciders has been recorded: but in the case of the samples now under consideration a bacillus causing the ropiness was ultimately isolated and had the following general characters:—

In neutral bouillon after 24 hours at 25°C.: A small rod, rather irregular in size; most common measurements 1·5 to 2·5μ by ·3 to ·5μ; often in twos and in short chains. Revolving motility in a few individuals. Involution forms not uncommon.

In 3–4 days old cultures a number of larger rods were forming, and the involution forms were increasing, many showing branched types.

Single Variety Ciders and Perries.

In each case the pomace was pressed immediately after milling, and allowed to ferment naturally in cask, without keeving (unless otherwise stated), until the specific gravity had dropped to 1·025—1·035 in the average case, when the liquor was filtered.

No.	Name of Variety.	District where Grown.	Date of Making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation at 28° C.	Special Treatment.	Specific Gravity May, 1917.
	APPLES—Sharp Varieties.								
1	Cap of Liberty	Long Ashton	Nov. 1st	1·049	·82	·17	4·7	....	1·018
2	" "	Backwell	Nov. 27th	1·046	·82	·28	1·8	....	1·030
3	" "	South Petherton	"	1·050	·67	·30	1·6	....	1·038
4	Unnamed	Weobley	Nov. 1st	1·058	·52	·28	5·6	....	1·024
5	Red Cap	Berrow	Nov. 11th	1·044	·82	·10	2·3	....	1·031
6	Unnamed	Chudleigh	Nov. 27th	1·053	·53	·13	2·9	....	1·025
7	Butter Box	Newton Abbot	Nov. 1st	1·052	·59	·15	2·5	....	1·035
8	Teign Harvey	"	Oct. 31st	1·052	·60	·30	1·7	....	1·036
9	Bickington Grey	"	Nov. 1st	1·055	1·13	·24	3·5	....	1·033
10	Frederick	Dingestow	Oct. 30th	1·052	1·12	·07	2·0	....	1·030
11	Kingston Black	Ledbury	Nov. 17th	1·053	·51	·33	3·5	....	1·024
12	" "	Hereford	Oct. 24th	1·058	·53	·20	2·8	....	1·031
13	" "	"	Nov. 3rd	1·059	·58	·20	3·4	....	1·034
14	" "	"	Nov. 20th	1·059	·58	·17	3·5	....	1·024
15	" "	Martock	Nov. 27th	1·049	·50	·16	1·7	....	1·030
16	" "	Hereford	Oct. 31st	1·052	·58	·18	2·8	....	1·025
	Sweet Varieties.								
17	Sweet Alford	Long Ashton	Nov. 1st	1·053	·23	·15	3·3	....	1·021
18	" "	Chudleigh	Oct. 31st	1·052	·32	·15	2·8	....	1·025
19	" "	Newton S. Cyres	Nov. 1st	1·050	·34	·18	2·6	....	1·031
20	" "	Newton Abbot	"	1·053	·24	·17	2·4	....	1·032
21	Slack-ma-Girdle	"	Nov. 2nd	1·052	·29	·14	3·2	....	1·030
22	Hancock's Seedling	Milverton	Nov. 20th	1·054	·27	·17	3·9	....	1·026
23	Truckle	Martock	Nov. 27th	1·051	·25	·15	2·8	....	1·023
24	Sheep's Nose	"	Nov. 1st	1·046	·24	·19	8·0	....	1·015

Single Variety Ciders and Perries—*continued.*

No.	Name of Variety	District where Grown.	Date of Making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation at 28° C.	Special Treatment.	Specific Gravity May, 1915.
	Bittersweet Varieties.								
25	Jersey ..	.. Martock ..	.. Nov. 1st	1·047	·24	·25	6·6	....	1·017
26	Tom Putt	.. Chudleigh ..	.. Oct. 30th	1·053	·30	·22	2·8	....	1·022
27	Strawberry Norman	Long Ashton	.. Nov. 2nd	1·049	·43	·37	7·1	....	1·020
28	,, ,,	.. Weobley ..	.. Oct. 30th	1·053	·31	·44	7·6	....	1·022
29	Pocket Apple	.. Newton Abbot	.. Oct. 24th	1·054	·24	·37	3·6	....	1 025
30	Cummy Norman	Weobley ..	.. Oct. 30th	1·058	·30	·32	5·3	....	1·024
31	,, ,,	.. Nunnington ..	.. ,,	1·055	·27	·29	3·1	....	1·028
32	Medaille d'Or	.. Long Ashton	.. Nov. 2nd	1·056	·32	·59	8·1	....	1·026
33	Chisel Jersey	.. ,, ..	.. ,,	1·051	·26	·29	4·1	....	1·023
34	Royal Wilding	.. Byford ..	.. Nov. 3rd	1·057	·21	·29	4·5	....	1·027
35	Cherry Norman	.. Hereford ..	.. Nov. 1st	1·052	·29	·34	3·6	....	1·024
36	Hangdown	.. Bow	.. Oct. 24th	1·054	·17	·33	4·3	....	1·023
37	White Jersey	.. Long Ashton	.. Sept. 26th	1·047	·20	·18	7·5	....	1·024
38	Horner ..	.. Milverton ..	.. Nov. 3rd	1·053	·17	·25	2·7	....	1·024
39	Royal Jersey	.. Martock ..	.. Oct. 30th	1·052	·21	·48	3·3	....	1·029
40	Chisel Jersey	.. South Petherton	.. Nov. 27th	1·058	·26	·50	2·2	....	1·038
41	White Norman	.. Weobley ..	.. Oct. 30th	1·052	·23	·40	3·1	....	1·031
42	,, ,,	.. Byford ..	.. Oct. 24th	1·054	·20	·37	2·4	....	1·029
43	Newton Jersey	.. Newton S. Cyres	.. Oct. 30th	1·055	·39	·42	2·4	....	1·034
	PERRY.								
44	Unnamed ..	.. Byford ..	.. Nov. 20th	1·043	·44	·11	3·1	....	1·031
	Cider Made From Mixed Fruits.								
45a	Mixture ..	.. Long Ashton	.. Oct. 18th	1·049	·62	·21	2·4	Not filtered or racked	1·004
45b	,, ..	.. ,, ..	.. ,,	,,	,,	,,	,,	....	1·006
45c	,, ..	.. ,, ..	.. ,,	,,	,,	,,	,,	....	1·021
46a	,, ..	.. Bow	.. Oct. 24th	1·053	·20	·32	3·0	....	1.022
46b	,, ..	.. ,, ...	.. ,,	,,	,,	,,	,,	....	1·023
46c	,, ..	.. ,, ...	.. ,,	,,	,,	,,	,,	Juice heated to 45–50°C. for 1 hour and added yeast No. 7	1·032

47a	Mixture	Taunton	Nov. 1st	1·050	·36	·19	6·1	Not filtered or racked	1·005
47b	,,	,,	,,	,,	,,	,,	,,	....	1·021
47c	,,	,,	,,	,,	,,	,,	,,	....	1·023
48a	,,	Martock	,,	,,	·30	·35	5·0	....	1·022
48b	,,	,,	,,	,,	,,	,,	,,	....	1·024
49a	,,	Chudleigh	,,	1·053	·46	·20	3·7	Not filtered or racked	1·022
49b	,,	,,	,,	,,	,,	,,	,,	....	1·026
49c	,,	,,	,,	,,	,,	,,	,,	....	1·026
50a	,,	Morchard Bishop	Nov. 2nd	1·049	·28	·13	4·8	Not filtered or racked	1·003
50b	,,	,, ,,	,,	,,	,,	,,	,,	....	1·018
50c	,,	,, ,,	,,	,,	,,	,,	,,	....	1·020
50d	,,	,, ,,	,,	,,	,,	,,	,,	Juice heated to 50°C. for 1 hour and added yeast 37	1·023
51a	,,	Martock	Nov. 11th	1·047	·42	·27	3·7	Not filtered or racked	1·031
51b	,,	,,	,,	,,	,,	,,	,,	....	1·022
51c	,,	,,	,,	,,	,,	,,	,,	....	1·024
51d	,,	,,	,,	,,	,,	,,	,,	Juice heated to 60°C. for 10 minutes and added yeast 37	1·028
52a	,,	Dingestow	Nov. 11th	1·052	·65	·25	4·1	Not filtered or racked	1·019
52b	,,	,,	,,	,,	,,	,,	,,	....	1·024
52c	,,	,,	,,	,,	,,	,,	,,	....	1·025
53a	,,	Martock	Nov. 21st	1·045	·52	·22	3·1	....	1·026
53b	,,	,,	,,	,,	,,	,,	,,	Juice heated to 50°C. for 1 hour and added yeast 7	1·029
54a	Cap of Liberty, Truckle, Dabinett	,,	Nov. 28th	1·047	·46	·21	3·6	Apples milled and pressed together	1·022
54b	,,	,,	,,	1·049	·51	·25	3·5	Apples milled together and macerated 24 hours before pressing	1·021
54c	,,	Long Ashton	,,	1·050	·46	·24	3·7	Juice of Cap of Liberty macerated 24 hours with pomace of the two other sorts before pressing	1·022

Spores have not been observed.

The bouillon shows very slight cloudiness after 24 hours and is after 48 hours cloudy with a small deposit, which forms strings when shaken up. Best development occurred in neutral and +1·5 bouillon; less in —1·5 bouillon. At room temperature development is slower. The organism grows well in yeast-water with added glucose; no development occurs in malt extract.

In +·5 *bouillon gelatine plates:* no visible development after 24 hours. After 48 hours small, white, uncharacteristic colonies. After four days colonies on surface about 5mm. broad, raised, smooth-edged. bluish-white in transparent light. Deep colonies very small. Slow liquefaction takes place; after two weeks the surface colonies have sunk a little and are seen as smooth-edged spheres surrounded by a 2mm. broad area, where the gelatine is liquefied; there is no growth in the liquefied area.

Bouillon gelatine stab: After four days 2mm. broad, smooth-edged, raised, glistening, dull-white development on surface a little sunk in middle; sparse uniform growth along stab. After 14 days, colony 3mm. broad with slight crateriform liquefaction.

Gelatine slope: After four days 1½mm. broad growth with slightly raised and undulating edges. After 14 days the growth has caved in to a depth of 3mm. and a certain amount of liquid with a white, flocculent, slimy deposit has collected at the bottom of the tube.

In +·5 *Agar-bouillon plates kept at* 25°C.: Colonies just visible after 24 hours. After four days surface colonies measure 1–1½mm. and are smooth-edged, round, raised, glistening white. Deep colonies small, white.

Agar-bouillon stab: shows after four days at 25°C. a 3mm. broad growth on surface of same appearance as above; white, uniform growth along stab.

On sloping bouillon-agar: there is formed after four days at 25°C. a 2mm. broad growth with raised slightly undulating edges of a greyish-white colour.

In fermentation tubes with bouillon plus 2% saccharose, glucose or lactose a vigorous growth with cloudiness, and a white, stringy deposit is formed in the open area; the liquid is clear and no gas development occurs in closed arm.

Development of acid: 10cc. of a 2% saccharose-bouillon culture kept at 25°C. for 14 days required ·8*cc.* N/10 soda for neutralisation. Glucose- and lactose-bouillon cultures under same conditions required 1·4*cc.* and ·6*cc.* N/10 soda respectively.

Indol formation.—No reaction for Indol after 10 days at 25°C.

Influence of organic acids.—To find the influence of organic acids

upon the bacillus, different proportions of malic, tartaric and citric acid were added to two tubes containing 2% glucose in yeast water and these were kept at 25° together with control tubes with no acid added. The results were the following :—

Malic Acid:

	After 1 week.	After 3 weeks.	After 6 weeks.
Tubes with ·2%	Some growth	Same as after 1 week	Same as after 1 week
" " ·4%	Small growth		
" " ·6%	Very small growth		
" " ·8%	No growth		
" " 1%	No growth		

Tartaric Acid:

Tubes with ·2%	Some growth	Same as after 1 week	Same as after 1 week
" " ·4%	Small growth		
" " ·6%	Very feeble growth		
" " ·8%	No growth		
" " 1%	No growth		

Citric Acid:

Tubes with ·2%	Some growth	Same as after 1 week	Same as after 3 weeks
" " ·4%	Small growth	Ditto	
" " ·6%	Very small growth	Ditto	
" " ·8%	No growth	Very feeble growth	
" " 1%	No growth	Very feeble growth	

Control Tubes: Very strong slimy growth.

The organic acids have consequently a pronounced preventative action upon the development of this organism, as had been anticipated, because ropiness is a disorder generally found in ciders of the sweet type, which contain only a small initial proportion of acid.

Ropiness is a disorder that is quite common in ciders in some districts, whereas it is hardly known in other districts. This is very probably due to the character of the mixtures of apples used; that is to say, if the mixture used contains a sufficient proportion of sharp apples to bring the initial acidity up to ·5 per cent. or more, there is not much danger of ropiness setting in. If, on the other hand, the mixture consists of sweet and bittersweet apples only or of such fruit mixed with sharps in insufficient quantity the disorder may turn up. Ropiness is in most cases fairly easy to cure; the method to use has been mentioned in an earlier report.

The disorder is sometimes called ropiness and sometimes oiliness, the two names denoting either two stages in the same disease, oiliness being the early stage and ropiness being used when the disorders is so far advanced that the whole liquid has a distinctly ropy character, or the term oiliness indicating a light attack and ropiness a bad attack.

A Note on Cider Vinegar.

Several enquiries have been received during the year as to the value of cider vinegar as a substitute for malt vinegar. Supplies of the latter are becoming short owing to the war, and the provision of adequate supplies of some other form of vinegar may become necessary. Cider vinegar is a satisfactory substitute and could be produced in considerable quantity if the necessity arose. A few notes on its method of manufacture are therefore given.

When cider is exposed to the influence of the air it goes quickly hard or sour and gradually turns into vinegar. It has been mentioned in earlier reports that this transformation is due to the action of bacteria, which by means of the oxygen in the air transform the alcohol contained in the cider into acetic acid, acetic acid being the chief constituent of vinegar. Thus cider-vinegar is the final product of a disorder known as acetification. To produce vinegar from apple juice two separate fermentations are necessary, namely, first the alcoholic fermentation brought about by a yeast, by which the sugars in the apple juice are fermented into alcohol and carbonic acid gas, and secondly the acetic fermentation caused by bacteria, by which the alcohol is oxidised into acetic acid. Finally, if the vinegar is left for a long time exposed to the air the acetic acid is gradually transformed into carbonic acid gas.

The vinegar made from cider will contain all the constituents of the cider resulting from the alcoholic fermentation of the apple juice with exception of the alcohol, which is more or less completely turned into acetic acid. To make a good vinegar from cider it must be made from pure apple juice fermented to dryness and containing 4 to 5 per cent. of alcohol by weight. By the acetic fermentation the alcohol should theoretically be transformed into acetic acid in the proportion 46 parts of alcohol to 60 parts of acetic acid. In practice this proportion cannot, however, be maintained, partly because a little alcohol always remains in the vinegar, partly because of evaporation during the fermentation. The proportion to expect would be as about 4 to 5, so that a cider containing 4 per cent. by weight of alcohol should give a vinegar with 5 per cent. of acetic acid.

To make vinegar from cider the following three conditions are necessary: (1) The presence in the cider of the acetic ferment; (2) Access of air; and (3) Temperature of 65°–85°F. The acetic ferment is present in all unpasteurized ciders, and one has only to leave a bottle open for some time at a convenient temperature to see it develop as a thick, leathery film on the surface of the liquid.

This film consists of a small rod-bacterium (*Bacterium xglinum*). To get a quick development of this "vinegar plant" a little vinegar can be added to the cider placed in an open vessel at a temperature of about 75°F.

A small vinegar-making plant for household purposes can easily be constructed in the following way. An ordinary cask with a capacity of, say, 6 gallons, is filled a little over halfway with a dry, completely fermented cider. To the cider can be added a little good vinegar. The cask is placed upon its side, provided with a wooden tap and a hole of about one inch diameter is bored in each end; one of the holes about one inch over the surface of the liquid in the cask, the hole in the other end close to the top. In the bunghole is inserted a small glass funnel, to which is attached a piece of rubber tubing dipping into the cider. To prevent access of the so-called vinegar flies, which deposit their eggs in the vinegar, the holes and the funnel are covered with a little fine gauze (cheese-cloth). The cask is placed in a warm room, and the vinegar making will soon start.

After about two months a sample is taken out through the tap, and if the temperature of the room has been sufficiently high, the vinegar will be ready for consumption. If the room has not been warm enough the process will take longer time, *e.g.*, 4 to 6 months. Thus vinegar can be made continuously by replacing the vinegar drawn off with dry cider poured in through the funnel.

With an apparatus constructed as above some very good cider vinegar has been made at the Institute. The vinegar was made from a dry cider containing 4·5 per cent. of alcohol by weight. It was perfectly clear when drawn from the cask, but after some time it became cloudy in bottles. This cloudiness can be overcome by storing the vinegar in closed vessels for some months and racking or filtering. If the vinegar is wanted quickly for bottling, the easiest way to prevent cloudiness setting in is to pasteurize the bottled vinegar by placing the bottles in a waterbath or steriliser, which is slowly heated to a temperature of 140°F. and kept at that temperature for 15 minutes. Cloudy vinegar can also be cleared by filtering or by first adding a clearing agent such as milk, which is used in the proportion of $\frac{1}{4}$ to $\frac{1}{2}$ per cent., *i.e.*, $\frac{1}{4}$ to $\frac{1}{2}$ gallon of milk per 100 gallons of cider. Vinegar prepared upon these lines has been used successfully for pickling purposes.

If it is desired to make vinegar from cider on a large scale a more elaborate apparatus is wanted of a similar construction to the vinegar-makers used in malt-vinegar factories, or as used for making vinegar from wine. This apparatus generally consists of a cylin-

drical wooden vat placed upon its end with two perforated wooden discs placed with an interval of varying height, the one above the other, near the top of the vat. Between the two discs is placed a layer of coarse wooden shavings or other similar material presenting a large surface. In the holes of the upper disc are often placed short lengths of cord hanging down in the layer of shavings, so as to distribute the liquid as evenly as possible. The vat has a certain number of air holes, so as to permit the air free access, and is kept in a warm room. The liquid to be acetified is pumped in over the top disc and slowly spreads over the wooden shavings, where it is exposed to the influence of the air, and the process of acetification soon starts. The acetified liquid is drawn out from the bottom of the cask and again pumped into the top of a vinegar-maker, and this process is repeated until the vinegar has the desired strength, which is usually from 4 to 6 per cent. of acetic acid. In the first instance the vinegar-maker isgenerally started with a pure culture of the acetic ferment. With an apparatus as outlined in the above it is possible to transform cider into vinegar at a quick rate.

INVESTIGATIONS ON DISEASES OF PLANTS AND THEIR TREATMENT.

NOTES ON THE FRUIT BLOSSOM BACILLUS.

In earlier reports mention has been made of the discovery of a bacillus causing a serious disease of fruit blossom—pear blossoms and fruit spurs of pear trees being particularly affected. It has been proved that this bacillus is carried on to the flower, where the disease generally starts on the receptacle, by the aid of insects. It has been reported earlier that this bacillus was found occasionally in the soil, and a series of experiments was carried out last spring to ascertain whether it was so common in the soil that it could be taken for granted that the infection was carried by insects from the soil on to the flowers.

Samples were taken during the first four months of the year from different places in the fruit plantations, vegetable plots, cider orchard and arable land at the Research Station. The samples were taken both at the surface and 6 inches below the surface. The method adopted was to shake a small lump of soil with 7–8cc. of sterilised water and make plate cultures in a medium consisting of 25cc. of malt extract (Sp. Gr. 1·050), ·5 gram potassium phosphate, ·1 gram magnesium

sulphate, and 50 grams gelatine in 500cc. of distilled water. This medium is very favourable to the growth of the fruit-blossom bacillus. The following were the results :—

On 36 plate cultures in	January : one colony only found.
" " " "	February : no colonies.
" " " "	March : no colonies.
" " " "	April : thirteen colonies found.

From this it appears that the bacillus is fairly common in the soil in April, but not earlier in the year.

During an investigation for another purpose, a bacillus which was identified as the one causing the fruit blossom disease was isolated from the root of a cabbage plant ; and a series of examinations of the bacterial growth upon the roots of different plants was subsequently carried out during the winter. This examination showed that the bacillus in question is commonly found adhering to the roots of many different plants.

The examination was carried out in the following way : surface and deep roots were taken with sterile forceps and placed upon the surface of solidified gelatine plates made with the medium given above. Plates were also made from sterile water, in which parts of the roots had been shaken up. The plate cultures were left at a temperature of 8–10°C.

The roots of the following plants were examined : Cauliflower, broccoli, Brussels sprouts, several varieties of cabbage, leeks, celery, strawberry, turnip, lettuce, tomato and grass. It was remarkable to observe that after 3 to 4 days an abundant growth of a bacillus, having the same easily recognisable characters as the fruit blossom bacillus, developed in all of a great number of plate cultures. This bacillus was present on the roots of all the plants mentioned in larger or smaller quantities, and in many cases very nearly a pure culture of the organism was obtained, only a few colonies of moulds and other kinds of bacteria developing. As an example the results can be given for the plate-cultures from the roots of a cabbage plant. After 3 days at a temperature of 8–10°C. small, greyish-white colonies were observed along the roots placed upon the surface of the gelatine. The fourth day the colonies had grown to a size of 2–3mm. They were round, with smooth, clear-cut edges, the gelatine being completely liquefied with a white flocculent deposit. The colonies soon grew together and formed a band of liquid gelatine about 10mm. broad along the roots. In 8 days the whole of the gelatine was liquefied and smelt strongly of ammonia. More

colonies were formed from the surface roots of the plant than from the deeper roots. Only very few colonies of other organisms developed upon the plate-cultures.

A piece of fine root, about one inch long, with the adhering soil was then well shaken up in 8cc. of sterile water, and from this plate cultures were made. After 3–4 days all the plates showed a great number of colonies of the bacillus and very few colonies of other organisms.

The characters of this bacillus correspond very closely with those of the fruit blossom bacillus, and in view of the recent publication of Miss E. M. Doidge's paper on a South African fruit blossom bacillus they may be given in detail for comparative purposes.

Description: A very motile rod bacillus with rounded ends; mostly in pairs, $2–4\mu \times \cdot 5–\cdot 8\mu$ in dimension. Flagellæ lophotrichic, two or more in number, four to five times as long as the cells themselves. The organism stains well, especially with gentian-violet. Spore formation has not been observed, optimum temperature 18°C.

In bouillon at 16–18°*C.:* After 24 hours in neutral bouillon slight cloudiness and thin ascending film. In +1·5 bouillon the same but the film a little stronger. In – 1·5 bouillon very slight cloudiness and no film. After 3 days, best development in +1·5 bouillon, thin, ascending film pronounced with ring sticking to tube, cloudiness and some deposit. After 8 days well developed film with wrinkled surface, liquid clouded with small white deposit and a feeble green fluorescence, especially in neutral bouillon. Both neutral and +1·5 bouillon alkaline to phenolphthalein.

Bouillon gelatine (+·5): In plate cultures colonies not visible after 24 hours: after 3 days surface colonies liquid, circular, smooth-edged, 3–5mm. in diameter. Content of colonies has a feeble green fluorescence, opaque with whitish deposit in middle. Deep colonies very small and uncharacteristic. After one week gelatine completely liquefied with smell of ammonia and alkaline reaction.

Gelatine stab: After 24 hours small liquefied crater with white deposit, greyish white development along stab; after 3 days, crateriform liquefaction about 10mm. broad, 3mm. deep, no liquefaction along stab; liquid opaque with white granular deposit in middle, green fluorescence. Half of the gelatine in tube liquefied in 6 days.

Gelatine slope: After 24 hours: ·5–1mm. broad, greyish white finely granulated streak with starting liquefaction, drops of liquid at the bottom of the tube. After 3 days a groove 6mm. broad

and 3–5mm. deep, smooth-edged, greenish fluorescence, liquid at bottom of tube with floculent white deposit.*

Bouillon agar: Plate-cultures show small, bluish white colonies after 48 hours, spreading on surface after 3 days, smooth-edged, raised. Deep colonies very small.

Agar stab: Raised growth on surface about 2mm. broad, after 48 hours, good development along stab.

Agar slope: Thin, whitish development, 1mm. broad. After some days growth spreads a little and edges get undulated.

Milk cultures give good growth; no coagulation had taken place after 8 days.

On potato: After 24 hours at room temperature, thin, raised growth of a white colour with smooth edges. After 48 hours 1–2mm. broad, yellowish. In old potato cultures the colour changes to brown. Grows well in sterilised soil.

The bacillus produced involution forms quite readily, especially when cultivated at 25°C. and in potato cultures.

In fermentation tubes: Neutral bouillon plus 2% saccharose, glucose or lactose show similar development. After 24 hours slight cloudiness in short arm, long arm clear. After 3 days short arm cloudy with deposit, no development or gas formation in long arm.

Production of Ammonia: After 7 days at room temperature in neutral bouillon 100cc. when distilled with magnesium oxide gave ·005 grams of ammonia.

In the determination of these characters, given cultures of the fruit blossom bacillus and the bacillus isolated from the roots, were used side by side and showed no material difference; the only sign of difference observed was that in some cases the root bacillus gave a feeble reaction for Indol, which has never been obtained with cultures of the fruit blossom bacillus.

As this bacillus was found so commonly adhering to the roots of many different plants it was thought possible that it might have some action, favourable or otherwise, upon the growth of the plants, and some experiments were carried out in that respect.

Pots with soil sterilized under 15lbs. steam pressure for 2 hours were seeded with sterile seeds of several brassicas. To one set of pots were added cultures of the bacillus; another was kept as a control. The seed germinated in nearly all cases quicker in the inoculated pots than in the controls, especially during the first

* Growth in the malt extract gelatine mentioned earlier always has a pronounced green fluorescence.

10 days. There was quite a remarkable difference, the size of the seedlings being as 2 to 1, and the soil of the inoculated pots was swarming with the bacilli in vigorous development.

Some experiments in the open were carried out with most of the common vegetables. Each kind of seed being sown in four rows, of which the two were watered when sown and later on once a week for five weeks with cultures of the bacillus, the two rows being kept as controls. These experiments did, however, not give any appreciable results, possibly owing to the fact that the soil in this case was naturally adequately supplied with the organisms in sufficient abundance.

Damping-Off and Collar Rot of Tomatoes.

Among the diseases to which tomatoes grown under glass are subject is a "damping-off" or "collar-rot" which has hitherto received little attention, though it is of wide-spread occurrence and sometimes causes serious losses in tomato houses. In some cases quite young seedlings which are only just showing their first rough leaves wilt and collapse, the stem being weak and shrivelled at the ground level. This is the "damping-off" stage of the disease. At other times the "collar rot" is met with, this being a shrinkage and discolouration of the stem at the collar followed by the collapse of the plant. Young plants several inches or almost a foot in height may be killed by this "collar rot," though attacked plants sometimes recover and grow into apparently healthy plants showing only a slight shrinkage and discolouration at the collar.

Serious attention was given to this matter last season when a grower found that whole batches of seedlings and whole houses of older plants were being killed by this disease. Specimens of the attacked plants of various ages were then examined and in all cases the tissues of the stem at the collar were found to contain the mycelium of a fungus. It may be as well to state here that the same fungus was found in diseased plants of all ages, the difference between the "damping-off" and the "collar rot" being due only to the different ages at which plants are infected. There is thus only one disease in question and most of the following observations apply to attacked plants of all ages.

The fungus mycelium was apparently that of a *Phycomycete*, but no form of fructification by which it could be identified was found either on the surface of the plant or within the tissues. When portions of diseased stem are placed in water, however, in the course of one or two days sporangiophores bearing sporangia grow

from the stem into the water. These sporangia are minute oval bodies which eventually burst and liberate still smaller spores which swim about in the water. The fungus is evidently a *Phytophthora*, a close relation of the fungus which causes "Potato Disease," but so far the actual species has not been identified as no form of fructification except the sporangia has been found. It has not yet been found possible to grow the fungus on artificial or sterilized media and thus to obtain a pure culture.

Healthy seedlings were planted in clean soil with pieces of diseased plants in contact with the stem just below the surface of the soil, and in three or four days the seedlings "damped-off" and on examination were found to be infected with the same fungus. Samples of soil obtained from a tomato house in which practically all the plants had been killed a few weeks before (in February) were then put in seed boxes. Several batches of very young seedlings were planted in these boxes and about half of them were attacked and killed within a week. Usually, if plants were not attacked within this time of being planted they did not become infected later, probably because the sources of infection in the soil were only local. At the beginning of April the boxes of infected soil were planted with healthy seedlings of various ages, the youngest having no rough leaves while the oldest were five or six inches high and had five or six rough leaves. Most of the youngest seedlings were quickly killed, while a few of the oldest plants were attacked at the collar, though not killed; and about half of the plants of intermediate age were killed. Later in the year seedlings planted in the same boxes of infected soil did not become diseased. This may be due to the soil having been allowed to get too dry, thus killing the source of infection in the soil, or to the fungus in the soil having a resting period and being inactive at this time of the year. Both these experiments and the experience of growers show that the fungus is most active and causes most damage in the first three or four months of the year. In November a fresh sample of soil was obtained from the same house where the disease had been bad the previous winter. This was planted with young seedlings, and a number of them were quickly killed, the same fungus as before being found to be the cause of death. It is thus evident that once a soil becomes inoculated with this *Phytophthora* the infection may be carried on from year to year in the soil, though we do not yet know in what form the fungus lives in the soil and produces the infection of seedlings planted there.

The original source of infection by this fungus has not yet been found, though as seedlings grown close to diseased plants, but in

clean soil, have never become infected it seems as though infection always takes place through the soil. Samples of maiden soil from rotted turf and of the manure used in the formation of borders in which disease has afterwards appeared have been used to try to produce disease in seedlings; but so far the results have been somewhat contradictory and no information on the original source of infection can yet be given.

The appearance of the disease can be prevented by sterilizing the soil in which tomatoes are to be grown, even if the soil has previously been infected. It has been suggested that in some cases the water-supply might be the source of infection, though it has never been proved that the disease actually has been introduced in this way. Sterilization of the soil would obviously be useless if infected water were used for watering. It is hoped that further investigations will reveal the way in which a soil originally becomes infected. Attempts are also being made to find some method of killing the fungus in the soil without injuring plants which are growing in it. If this can be done the treatment could be applied to the soil on the first appearance of the disease among the plants growing in it and the rest of the crop could be saved.

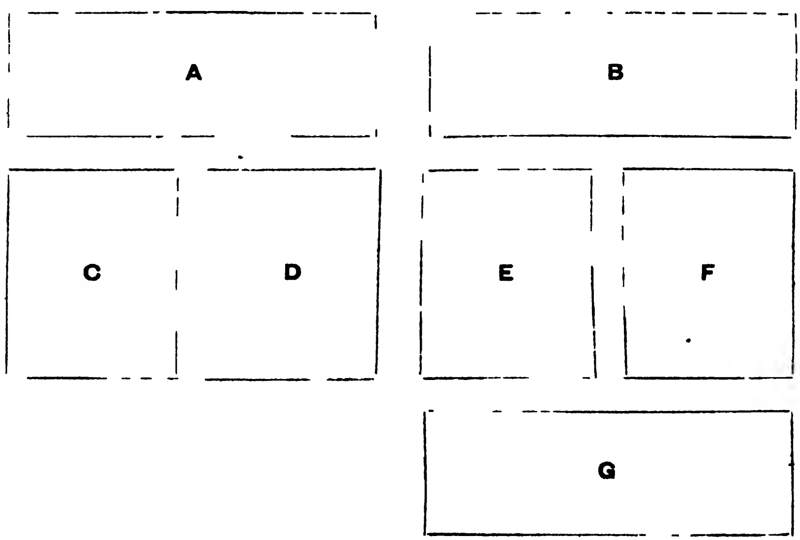
Further Experiments on the RHIZOCTONIA Disease of Asparagus.

The Annual Report of the Station for 1916 contained an account of an outbreak of disease in an asparagus plantation at Badsey, near Evesham, caused by a soil fungus, *Rhizoctonia violacea*, var. *asparagi* (*R. medicaginis. De C.*), and of a series of experiments conducted on the infected land with the object of finding a substance capable of eradicating the pest. An infected portion of the land was divided into a series of seven plots, one of which received no special treatment, while the remainder were treated respectively with bleaching powder (2oz. per sq. yd.), carbolic acid (2oz. per sq. yd.), creosote (1oz. per sq. yd.), lime (30oz. per sq. yd.), naphthalene (2oz. per sq. yd.), and sulphate of iron (¾oz. per sq. yd.). In the first five instances the fungicide was applied in early spring, a few weeks before the test crop was sown. The sulphate of iron was applied in two separate dressings at intervals during the summer, while the test crop was in active growth. The crop selected was carrot, this being more suitable for the immediate purpose than asparagus and equally susceptible to attack. The results showed that each of the fungicides tested checked the development of the disease, the untreated control plot showing very much more disease

than the other six plots. The most striking effect was obtained with bleaching powder and creosote. The results with carbolic acid and naphthalene were not regarded as sufficiently promising for it to be worth while testing those substances further: but in the other four cases it was decided to proceed with similar trials in 1917.

The results from the latter trials are now available and not only confirm the 1916 work but afford ground for hope that an effective method of dealing with pathogenic soil fungi may at last be evolved. The general procedure adopted was the same as in 1916. The plots were treated with the respective fungicides towards the end of the second week in April except in the case of sulphate of iron, which was applied as before, and the carrot seed was sown at the beginning of May. The individual plots were dressed with the same substances as in the previous year, and the two plots treated with carbolic acid and naphthalene that season were on this occasion given dressings of bleaching powder and creosote respectively at the strengths above mentioned. The control plot of 1916 served as the control plot for 1917.

Owing to pressure of other work little attention could be given to the plots until the lifting of the cropin November. Con sequently the plants remained unthinned and the size of the individual roots was small. This, however, was a detail of little account so far as the actual trials were concerned, for the crops on all the plots were of uniform character except in respect of the



disease under investigation. The application of the fungicide in no case resulted in any obvious interference with the germination of the carrot seed; and the subsequent growth of the crop showed that, whatever effect the fungicides in question might have upon growth conditions in the soil immediately after application, an interval of three weeks, as given in these experiments, between that time and the sowing of the seed is sufficient to allow any toxic effect to wear off.

The plan on page 131 shows the position of the individual plots.

The treatment of the plots was as follows:—

Plot A.	1916.	Lime.
,,	1917.	Lime.
Plot B.	1916.	Sulphate of Iron.
,,	1917.	Untreated.
Plot C.	1916.	Creosote.
,,	1917.	Creosote.
Plot D.	1916.	Carbolic acid.
,,	1917.	Creosote.
Plot E.	1916.	Untreated.
,,	1917.	Untreated.
Plot F.	1916.	Naphthalene.
,,	1917.	Bleaching powder.
Plot G.	1916.	Bleaching powder.
,,	1917.	Bleaching powder.

In order to give a fair comparative idea of the extent of the disease on the individual plots, as shown at the time of the lifting of the crop in November, 1917, an attempt was made to estimate it numerically. The control plot, E, was obviously the worst and the amount of disease thereon was accordingly expressed by the number 10. Plots A and B came next in order of disease, and the amount in these cases would be fairly expressed by 7 in comparison with the standard of 10 for the control plot. Plots C and D were marked 4 and 3 respectively, and Plot F 2. On Plot G there was merely a trace of disease and this was accordingly marked 1.

In view of the central position of the control plot, E, it is evident from the more or less marked reduction in the amount of disease on all the plots surrounding it that each of the fungicides tested has had some beneficial effect. At the same time the reduction in the amount of disease on the plots treated with lime and sulphate of iron (Plots A and B) has not been sufficient after two years' treatment

to offer much encouragement of ultimate success under practical conditions. The results with creosote on Plots C and D were distinctly more encouraging, much more so in fact than the numerical estimate would indicate. What disease was present on these plots was almost entirely confined to two or three small areas, which suggests that the practical difficulty of ensuring uniform distribution of the fungicide over the whole area may have accounted for a few local areas being insufficiently treated. In addition, rain fell during the night after application of the material and this probably would serve to render the distribution of such a substance as creosote more irregular. The results with creosote in 1916 were so pronounced that these considerations should have some weight in estimating the 1917 returns: and for that reason it has been decided to include that substance in the more extended trials which it is hoped it will be possible to carry through in 1918. On the figure basis bleaching powder certainly appears to be the most efficient of the substances tested, its effect being strongly pronounced both in 1916 and 1917: and the proposed 1918 trials will be mainly concerned with more exhaustive tests of its action.

It is believed that the positive results obtained in these trials have been due very largely to the time of application of the fungicides which were selected. Having in view the irregular results which had been obtained in previous work on the treatment of pathogenic soil fungi, it is considered that the question of time of application of the toxic substance is probably of primary importance in cases such as that of the *Rhizoctonia* here in question, in which the fungus seems definitely to winter in the soil in a resting condition. In that state it may be presumed that the organism during that period is in a form more or less highly resistant to the action of ordinary fungicides. *Rhizoctonia*, for example, exists in its sclerotial stage during the winter months and in this form must be undoubtedly more difficult to kill than in its actively growing mycelial form which develops when the soil temperature rises during spring and summer. The natural period for attack would, therefore, appear to be during spring and early summer before a new crop of sclerotia has had an opportunity of being produced. Hence the period selected for soil treatment in these experiments was during the spring, after the soil temperature had begun to rise. Owing to the necessity of allowing a sufficient margin of time to elapse for the injurious effect of the fungicide on plant growth to wear off, the actual time of application adopted, viz., mid-April, had perforce to be somewhat on the early side; and if it had been possible to defer application, a somewhat later date might have shown a still more decisive result.

This point is obviously of importance in connection with the general treatment of pathogenic soil fungi on these lines. It is clearly necessary to take into account both the life-history of the parasite, in order to decide the phase offering most promise of attack, and also the nature of the host-plant, in order to determine to what extent attack by direct fungicidal action is possible. In the present case, in view of the above results it appears that it would be comparatively easy to control the pest on an infected area of ground so long as a host-plant like the carrot was grown. Being an annual crop the sowing can be deferred until the land has been treated with a fungicide and time allowed for the toxic effect of the latter to lapse. With asparagus, the other type of host-plant involved in this instance, the problem is considerably complicated by the fact that the crop remains on the land for several years and its roots doubtless run the same risk of injury as the parasite itself during soil treatment with fungicides.

The next step in the present investigation, therefore, must be to determine how the fungicide can be applied with maximum injury to the parasite and minimum damage to the host. The method of solution of this problem will probably depend upon the extent to which the fungus has become distributed in an infected plantation. Soil fungi as a rule spread comparatively slowly. In the present case on the heavy clay land at Badsey the *Rhizoctonia* does not advance much more than one yard a year. Consequently if infection is localised in a comparatively few centres in a plantation, these may be separately isolated and the parasite eradicated within the infected area. The sacrifice of the relatively few host-plants in those areas would be a comparatively small matter. On the other hand, if its distribution is general the sacrifice of the whole crop would be serious and some other line of action would have to be sought.

Acknowledgment must be made of the valued assistance which had been rendered by Mr. R. C. Gaut, the Agricultural Organiser for Worcestershire, Mr. Hall, the tenant of the land at Badsey, and Mr. A. H. Lees, of this Station. The whole of the work involved in the 1917 trials has been carried through by them, and without their help the experiments must have been discontinued until the conclusion of the war.

"Reversion" of Black Currants.

In the Report for 1916 the connection between Big Bud and Reversion was discussed at some length for Long Ashton conditions. Further cases have since been investigated, especially

some interesting material sent by Messrs. Seabrook & Sons, of Chelmsford. This material has thrown considerable light on some rather obscure cases. This variety is resistant to Big Bud, that is, under ordinary circumstances it does not develop the disease at all badly though it may show isolated big buds which do not, however, increase in number. The reasons for the resistance will be found in a separate article.

Here, as in the Long Ashton cases, the first cause of the disease was found in the interference by mite with the normal terminal growth. The check thus given to the terminal causes the lateral buds to make an abnormal growth the following year and consequently the bush becomes filled with lateral wood. Thus a similar result is obtained as in the mited Long Ashton material described in the Report for 1916.

Amongst the material from Messrs. Seabrook were some reverted shoots which showed extremely little or no sign of mite attack. Here a different cause was found. In nearly every case the terminal bud proved to be a flower bud. The flower bud in the black currant consists of a central rudimentary flower and two accessory lateral growing points. When, therefore, a flower bud is present at the terminal point of the shoot a check is given to terminal growth during the following spring until such a time as one or both of the accessory growing points take up true terminal growth again. The result is, as in mite-checked terminals, that abnormal growth is made from the lateral buds.

The terminal flower bud was found to occur only on shoots that were making a comparatively weak growth. Several causes may act to induce weak growth. Firstly the bush as a whole may be in a weak condition. Secondly, a wrong system of pruning may have been adopted. A sucker in its first year makes a strong growth and nearly always has a wood bud terminal. In its second year it is weaker, but usually has a wood bud terminal. In its third and fourth year the growth is still weaker and has nearly always a flower bud terminal. If, therefore, suckers are allowed to grow for more than three years there is a great tendency for reverted wood to form, and consequently also for running-off of the fruit. In the best pruning methods no fourth year wood is allowed to remain and only a very little third year. Thirdly an aphis check in the summer may cause two or three terminal growths to be formed instead of one. These being weaker are nearly always capped by flower buds with a consequent tendency to reversion.

Fuller details of these cases are being published in the Annals of Applied Biology.

THE RASPBERRY AND LOGANBERRY BEETLE (*Byturus tomentosus*).

This raspberry pest is widely spread and it is a common experience to find fruit infested with the small grub that is its larva. Its presence considerably lowers the market value of the fruit and absolutely bars it from being used for canning. Since logan culture has increased the insect has shown a preference for this fruit so that where both kinds are grown together the raspberries remain comparatively free.

As soon as the weather becomes warm in the spring it appears from the soil underneath the plants where it has hibernated. If the raspberry or logan flowers are not yet open it attacks the young growing points of the plants and may also be found in apple flowers. When the logan and raspberry flowers begin to show it attacks these in great numbers. In bad cases three or four beetles may be found in a flower. They feed on the tissue at the base of the flower, the nectaries being probably especially attractive. As they feed they destroy the base of the stamens but otherwise do not do much direct damage. Very soon, however, the fertilised females begin to oviposit and the young larvæ burrow in the receptacle and later attack the fruit itself. The fruit may become entirely aborted or may be only one-sided in growth. The larvæ in the course of its feeding usually comes to the surface with the result that the skin is broken. Such spots are quickly attacked by moulds and thus still further reduce the value of the fruit.

Remedies.—Lead arsenate has not met with much success since the beetle does not feed on the leaf and it is very difficult to get the poison into the flowers. The usual method adopted is to shake the flowers over pans filled with tree grease. The shaking has to be fairly violent as the beetles do not drop readily, especially on dull days, but by this method large numbers can be caught. It does not suffice, however, to keep the fruit free in bad cases. Ordinary contact washes fail to kill the beetle, in most cases at the best merely anæsthetising them. The beetle is indeed difficult to kill by contact washes.

An opportunity occurred in the spring of 1917 to test the effect of a spray mixture which had already given good results against the beetle on a small scale. This mixture has the following formula :—

Soft soap	20lbs.
Paraffin	2 gallons
Nicotine	½lb.
Water	100 gallons

The soap is dissolved in 5 to 10 gallons of boiling water and the paraffin thoroughly emulsified into it by means of a syringe. The nicotine is then added and the mixture finally made up to 100 gallons. As explained in previous reports this 2 per cent. paraffin emulsion has great wetting and penetrative powers and serves as a carrier to the nicotine. By its means the poison is brought as intimately as possible into contact with the insect.

The plantation on which the experiment was made was very badly attacked and the experiment was made on a scale large enough to give results on a commercial scale.

In practice it was found necessary to give a preliminary spraying in order to force the insects from their hiding places. For the purpose the 2 per cent. paraffin emulsion without nicotine was employed. Unless this were done the nicotine spray failed in its action simply because very few of the beetles were thoroughly wetted.

The method employed was to send one knapsack sprayer containing paraffin-emulsion on in advance and to follow up five minutes later with a second containing nicotine-paraffin-emulsion. By this time the beetles had come out of their hiding places and a good kill was secured. This double spraying was done three times during three weeks and then stopped.

At the ripening time a count was made and it was found that whereas in control rows 100 per cent. were infected in sprayed rows only 33 per cent. were. Since the sprayed portion was only a small part of the whole, re-infection from uncontrolled parts probably occurred. In addition only three double sprayings were done though at the end there were still fresh beetles appearing. These two factors probably caused the result to be worse than it otherwise would have been.

Further Experiments on Big Bud Mite.

Since the mixture of 10 per cent. soap and 5 per cent. crude carbolic acid had been shown to be effective in killing big buds in the winter condition further experiments were made in its use in the winter of 1916–17. One spraying was usually sufficient to penetrate and kill big buds situated low down on the shoot but was much less effective on terminal big buds and those situated high up. The reason for this is, of course, that the low big buds, being first formed, are relatively older and, therefore, more loose in structure. Consequently the spray fluid penetrates more easily. There was also some doubt at to what was the best time during the winter season to spray.

Accordingly the two varieties, Boskoop Giant and Ogden's Black, were sprayed at three different times, namely (*a*) at the beginning of December, (*b*) at the beginning of January, and (*c*) at the end of February. In addition some bushes were sprayed at (*a*) and (*b*) and (*a*) and (*c*).

In the spring the number of killed and living big buds were counted on each experimental plot, giving the following results :—

Treatment	Ogden's Black Big Buds		Boskoop Giant Big Buds	
	% killed	% living	% killed	% living
(*a*) ..	60	40 (2·0)	63	37 (2·75)
(*b*) ..	65	35 (2·83)	52	48 (2·5)
(*c*) ..	71	29	58	42
(*a*) + (*b*) ..	86	14 (1·33)	65	35 (2·33)
(*a*) + (*c*) ..	83	17 (1·66)	79	21 (1·83)

Looking at the results from the Ogden's it is evident that none of the times selected gave appreciably better results than the others when one spraying only was given. The figure for (*c*) included too few bushes to be reliable. Two sprayings, at whichever time done, at once reduced the percentage of living big buds. The results with the Boskoops were not nearly so good and, indeed, it has long been noticed that the big buds on this variety are particularly difficult to penetrate.

Other bushes including "French" Lee's Prolific, Black Naples, Victoria and Baldwyn were also given two sprayings at times (*a*) and (*c*) and (*b*) and (*c*). Counts of killed big buds were not made in this case as the distribution of big buds was very irregular.

This experiment included six rows of bushes. Three others were left as a control and three more sprayed with lime-sulphur at winter strength at the beginning of April.

In the Big Bud experiments carried on at Long Ashton for a series of years it has been the custom every winter to give each bush under observation marks indicating roughly the degree of attack. Thus 0 means none visible, 1 is slight, 2 is moderate, and 3 bad. The figures for the previous year therefore give a much better control for any particular bush than any obtained from bushes outside the experiment since in any collection of bushes the distribution of big bud is often most irregular.

In the foregoing Table the figures in brackets indicate the average degree of attack for the bushes (about six in number) under the different spraying treatments. The previous year they were all over 2·5, being badly attacked.

In the Ogden's Black the figures for the winter of 1917–18 follow fairly closely those for living big buds obtained in March, 1917. The double spraying has in both cases given markedly better results. It is somewhat remarkable, however, that when the percentage of living big buds has been brought down to 14 so much infestation occurs in the following year. It is obviously necessary to bring the percentage down nearly to zero before a satisfactory result could be obtained. The Boskoops give rather irregular figures though one of the double sprayings is decidedly the best.

The results given in the following Table show that the early and late sprayings gave the better result. There was no decided result from lime-sulphur.

TABLE.

	Victoria		Baldwyn	
	1916	1917	1916	1917
1st 3 rows (*a*) and (*c*)	1·4	1·1	·8	·9
2nd 3 rows (*b*) and (*c*)	1·47	1·9	·66	1·1
3rd 3 rows lime-sulphured ..	1·64	2·0	1·5	2·2
4th 3 rows (Control)	1·3	2·6	·85	1·25

On the whole the indications are that the early spraying is important when a double spraying is done and that probably three sprayings would give a better result than two.

Copper Stearate.

Burgundy and Bordeaux mixtures have been now for many years recognised as reliable fungicides. Their action is protective and protective only. They have no contact fungicidal powers nor do they spread easily when sprayed on to a leaf or fungus mycelium.

Trials were made at Long Ashton two or three years ago in order to find some means of remedying these deficiencies.

Since 2 per cent. paraffin emulsion (2 per cent. soap, 2 per cent. paraffin) was known to give the highest wetting and spreading power, an attempt was made to combine soap with Burgundy mixture. Bordeaux mixture was obviously unsuitable owing to the excess of lime which immediately precipitated the added soap. When added to Burgundy mixture made in the ordinary way interaction took place between the copper compound and soap resulting in a curdy precipitate. The soap was thus rendered inactive.

To overcome this difficulty the addition of ammonia to copper sulphate before adding the requisite amounts of sodium carbonate and soap was tried. This resulted in a stable mixture but required rather a large amount of ammonia. When sprayed the ammonia gradually evaporated, leaving the copper sulphate to react with the soap. The surface was thus finally covered with a copper soap which for the sake of simplicity may be called copper stearate.

It was found that far less ammonia need be used if a certain amount of caustic soda were added at the same time as the carbonate and soap. The resulting mixture, however, was found to cause defoliation, when used either alone or with emulsified paraffin, on gooseberries. In addition, it did not appear to have very satisfactory protective properties. The mixture was therefore given up as useless. At the same time the possibility of a simple mixture of copper sulphate and soap was ruled out by the fact that when soap was added to copper sulphate an exceedingly sticky and unmanageable compound was obtained.

It was not until a considerable time later that it was found that if the mixing took place in the reverse way, that is by adding copper sulphate solution to soap solution, an entirely different result could be obtained as long as the soap was in excess and the solutions sufficiently dilute. Thus when 20cc. of 1 per cent. copper sulphate is carefully added to 100cc. 1 per cent. soap solution with constant stirring the mixture assumes a characteristic opaque light blue colour. This proved to be due to an exceedingly fine precipitate of a copper soap compound. When a thin film is dried on a slide and examined under a 1/6 objective it was found to consist of an enormous number of exceedingly fine, barely visible particles. Their exceeding fineness results in the mixture being non-filterable and to the precipitate remaining suspended for days with only very slight settling. It also accounts for the opacity of the mixture. In fact the particles appear to be in a state of emulsion in the soap solution.

If much more than 20cc. of 1 per cent. copper sulphate is added to 100cc. of 1 per cent. soap solution the physical nature of the mixture is changed, all the fine copper soap particles running together to form a thick sticky mass. In this respect it behaves like an oil emulsion in soap which de-emulsifies as soon as the emulsifier is destroyed in any way.

The copper soap formed was found to be a mixture of the salts of stearic, palmitic and oleic acids. Since stearic acid is usually present in preponderance the compound may be called for the sake of convenience, copper stearate. Of course, for any particular

soap used the resulting copper compound will depend on the fatty acids originally present. In view of the frequently changing composition of soft soaps due to war conditions it is impossible to lay down any hard and fast rule for its composition.

Dilute acid causes the blue of the mixture to change to white, doubtless due to the formation of the fatty acid from the copper soap. The resulting soluble copper salt is too dilute to affect the colour. Alkalies also cause a paling of the blue into a less dense and lighter blue. This change is probably associated with the formation of copper hydroxide and reformation of the original soap. The speed with which these two reactions take place is evidence of the fineness of the precipitate and reminds one of the behaviour of a solution rather than a precipitate.

As the mixture contains soap in excess it is possible to increase the wetting powers very greatly by combining it with a 2 per cent. paraffin emulsion. The combined mixture remains homogeneous except for the fact that the paraffin soap emulsion tends, as in the simple paraffin soap emulsion, to rise to the surface. The combined mixture will wet resistant surfaces like the summer stage of American Gooseberry Mildew with ease. Without paraffin emulsion the copper stearate mixture has a good spreading power on ordinary foliage and when dry leaves an almost imperceptible film of exceedingly fine and close particles.

The size of these particles averages 2–3 μ though a few considerably coarser particles are generally present. The space between any two particles varies from about 2–5 μ. It would, therefore, be impossible for a germinating fungus spore to penetrate a sprayed leaf without coming into contact with several particles. For practical fungicidal purposes therefore the coat may be regarded as continuous. Such a sprayed surface has one further advantage. It resists wetting completely, water running off it in drops instead of spreading. This may be due to very slight decomposition of the copper stearate into stearic acid, or it may be a property of the stearate itself.

The strength of the copper in the mixture is ·16 per cent., that is about $\frac{1}{8}$ per cent. of that in the formula recommended for Burgundy mixture by the Food Production Department. If the mixture is brought up to 1 per cent. of copper sulphate the physical properties are partially destroyed as a certain amount of the copper stearate runs together into curdy masses. It may, however, be brought to a percentage of 1·6 by dissolving a small quantity of gelatine in the stronger copper sulphate before addition of the correspondingly stronger soap solution.

It is not yet known whether the mixture possesses fungicidal properties. The fact, however, that it is easily decomposed by dilute acids renders it quite likely. It would appear probable that the protoplasm of a germinating spore would render a certain amount of copper soluble just as it does in the case of Burgundy mixture.

In order to get some light on its possible fungicidal properties bean seedlings were grown in the mixture. As a control others were grown in a ½ per cent. soap solution. This was done to see if the small amount of alkali had any effect. Since the mixture is non-filterable the effect of the precipitate by itself could not be tried as may be easily done for Bordeaux and Burgundy mixtures. The beans grown in copper stearate emulsions showed blackened areas on the root above the liquid, but the portion in the liquid appeared normal. Those grown in ½ per cent. soap solution had their roots completely blackened. Similar results were obtained for mustard grown on flannel soaked with the emulsion and dipping into it, and for mustard grown on flannel dipping into ½ per cent. soap solution. The results, therefore, gave no indication whether the copper stearate was injurious to root hairs. In order to avoid this difficulty a different method was adopted. Sufficient sand to fill a 4-inch pot was wetted with copper stearate emulsion and dried gradually. It was then placed in the pot and thoroughly well washed with water till no soap or alkali could be detected. Bean seedlings grown in this sand showed blackening of the roots comparable with that obtained with beans grown in a Bordeaux precipitate. To test mustard, flannel was soaked in the stearate emulsion, dried and thoroughly washed with water. Seed sown on this surface and kept moist showed a very small per cent. of germination compared with a control on flannel moistened with water. Those that did germinate showed blackening of the root tips.

These experiments appear to show that copper stearate is sufficiently dissolved by root hairs to cause copper poisoning. It is likely, therefore, that it will prove fungicidal.

The Manufacture of Cider Apple Jelly.

In view of the fact that it was evident that there would be need for as large supplies of jam and analogous products as could be produced until the 1918 fruit crop became available it was decided by the Food Production Department of the Board of Agriculture to attempt to utilize a portion of the abnormally great cider fruit crop of 1917.

Cider apples and perry pears represent the only considerable supplies of fruit not normally used in some form for food purposes, being converted exclusively into cider and perry except in seasons of scarcity, when certain kinds of such apples and pears are drawn upon for jam-making and, to a less degree, for dessert and culinary use. The total acreage of grass orchards of apples and pears in the West of England is about 100,000 acres. These orchards are comprised mainly of cider and perry fruit. A big and hitherto largely untouched source of material of potential food value is thus available, provided that suitable methods of dealing with the crop are adopted.

No attempt was made in 1917 to utilise perry pears. Attention was concentrated on cider fruit.

Cider apples may, as already frequently indicated in these Reports, be divided into three main groups : (*a*) sours, (*b*) sweets, (*c*) bittersweets. The sours are distinguished from the other two classes by their relatively high content of malic acid, the amount in the average case well exceeding ·45 per cent. of acid in the juice. The acidity of sweet and bittersweet apples is normally much below that figure. The only difference of importance between the two latter classes is that the bittersweets contain appreciable quantities of tannin, which substance occurs only in very limited quantity in the sweet varieties. For present purposes these two classes may be treated as one, since their mode of use from a food point of view is identical.

Hitherto it has only been the sour varieties which have been drawn upon to any extent to make good any deficiency in the crop of ordinary table apples. Their utilisation presents no difficulties, the quantity of acid contained being sufficient to furnish the necessary cooking qualities for culinary purposes and the "setting" or "jellying" properties for jam-making. Arrangements were therefore made in the West of England for the 1917 season to deal extensively with this class of fruit for the production of apple pulp for jam making, and the major portion of the apples pulped at the respective centres organised there as well as those dispatched to other stations in other parts of the country were of this type.

The other types, however, have not been utilised previously to any extent on a commercial scale for food purposes and the work in this direction which has been carried out during the 1917 season must, therefore, be regarded as largely of an experimental character. The form of product which it was decided to make was the type of apple jelly evolved as the result of experiments carried out at Long Ashton in 1914. In essentials the method consists

simply in concentrating the freshly expressed juice of the fruit until the content of sugar approximates to 65 per cent. The concentration is effected by heat and, when cool, the thick liquor sets to a more or less firm jelly which possesses an intensified apple flavour. Natural apple juice in an average season contains about 10 per cent. of total sugar. The juice, therefore, must be reduced to about 1/7th of its original volume, if no other sugar is added. It is found in practice more economical to add approximately the same amount of sugar as occurs naturally in the juice. The extent of concentration required is then reduced by one-half, a larger yield of jelly is obtained from a given weight of fruit, and there is a considerable saving of time. The quality of the jelly is also considered by most people to be superior. The added sugar may be either cane sugar, glucose, or corn syrup. In most cases during the past season a mixture of equal parts of cane sugar and corn syrup was used and gave very satisfactory results.

Stations.—On behalf of the Food Production Department two centres for the manufacture of this jelly were organised in 1917, viz., at the Research Station, Long Ashton, and at Wedmore, near Cheddar. Long Ashton was selected—in spite of its not being located in a large apple growing district—on account of the facilities for conducting the necessary experiments on the method of making. Wedmore, although awkwardly situated as regards railway service, is in the midst of a large fruit district, and growers were keen to develop a local industry for their cider apples.

At Long Ashton accommodation for the required plant was provided in the cider house at the Research Station, and premises for the storage of the jelly were obtained near the railway at Flax Bourton. The Manager of the Station, Mr. E. P. West, undertook the general charge of the work, the technical side being looked after by Mr. Grove with Mr. Spinks' assistance.

At Wedmore a small house and workshops adjoining were secured as working premises, and the main storage accommodation was provided at Cheddar Station, the nearest point on the railway. The general management was in the hands of Mr. W. G. Burrough, of Wedmore, assisted by a small local committee, and Mr. Warneford, a member of the staff of the Food Production Department, took charge of the making of the jelly during the greater part of the season.

Plant.—The requisite plant for jelly-making consists of :—

(*a*) a mill and press, for extraction of the juice from the fruit,

(*b*) an evaporator, for the concentration of the juice.

Mills and Presses.—Ordinary cider mills and presses serve perfectly well.

At Long Ashton an American type of "grater" mill and a hydraulic press, used at the Research Station for cider-making, were available. The yield of juice per ton of fruit with these machines averaged 150–170 gallons according to the period of the season. At Wedmore an ordinary type of "crusher" mill and two small hand-power presses of a primitive type had to be used, insufficient time being available to obtain more efficient apparatus. These were adapted so as to be driven by electric power. The yield of juice per ton of fruit rarely exceeded 120 gallons. This low figure was largely due to the inefficiency of the machines and was one of the chief contributing factors to the relatively high cost of making the jelly at Wedmore.

Evaporators.—It has been possible as a result of the season's working to obtain important information as to the most efficient type of evaporator for this particular purpose.

The simplest form is the ordinary steam-jacketed jam-boiling pan. This is the least satisfactory type of apparatus, being open to the objection that, not being a continuous working form, the whole of the juice dealt with in one operation has to be subjected to a high temperature until the volume is reduced to the required point. This involves a relatively long period of cooking with consequent partial caramelisation of sugar and, therefore, considerable darkening of colour and the acquisition of a more or less distinct burnt flavour. The "setting" property of the jelly is to some extent affected. The process is also comparatively slow. The usual type of steam-heated vacuum boiling pan is an improvement, but this form is also open to the same objection of not being continuous in its working. Caramelisation is, however, considerably reduced, and colour and flavour accordingly are improved. The speed of evaporation is increased, but the output does not reach that of a continuous working apparatus.

The evaporator used at Wedmore was one constructed on the lines of certain American juice evaporators. It consists of a long narrow wooden trough divided into two compartments by a partition running nearly the whole of its length. The two compartments are entirely partitioned off from each other by this at one end, the fresh juice being fed into the one division at this end and the outlet for the concentrated juice being situated at the corresponding point in the other compartment. The two compartments communicate at the far end, where the partition does not extend quite the full length of the trough. The bottom of the trough is made slightly sloping in such a way that the incoming juice flows along the first compartment to its point of communication with the

second compartment at the far end and thence returns in the opposite direction along the latter to the point of outlet. Three copper steam pipes are fixed just above the floor of the trough in each compartment and these are heated by steam at 80lbs. pressure. The juice in its flow from inlet to outlet is gradually concentrated, and by regulation of the rate of feed of juice the desired degree of concentration is obtained. A wooden cover is fitted over the whole trough and a central flue to carry off the evolved steam from the boiling juice is provided.

This evaporator has the advantage of being continuous in its working but proved, unfortunately, to be difficult to regulate. Variations in steam pressure affected the rate of flow to such an extent that constant attention was required, and a number of other causes contributed to produce such serious irregularities in the flow that occasionally the steam pipes near the outlet would become partially uncovered, leading to burning of the concentrated juice, while at other times juice incompletely evaporated would be delivered. It was with great difficulty, therefore, that anything approaching uniformity in the product was obtained. The speed of the apparatus proved to be much slower than had been anticipated and the cost of concentration was accordingly relatively high. The quality of the product was, on the whole, fair: the colour was generally rather too dark and the flavour at times showed traces of burning. The jelly as a rule set moderately well, but showed a tendency to be hygroscopic and during damp periods in December liquefied somewhat. Under drier conditions this is now setting again. The principal drawbacks of the apparatus are the slow rate of output, the high cost for concentration and the difficulty of securing uniform working.

The apparatus used at Long Ashton was the Kestner Evaporator. This is a machine extensively used for a variety of chemical and industrial purposes. Since it is somewhat complicated in construction, no detailed description will be given here. In essentials it consists of a continuous series of copper tubes, on the interior surface of which the juice travels as a thin film. The tubes are heated externally by steam under pressure and the juice in its passage through them is gradually concentrated. The most suitable pressure found during the past season's working with apple juice was about 30lbs. A special arrangement at the delivery end of the tube system provides for the separation of the evolved steam from the concentrated liquid. The machine is a continuous working one. It can be operated with the treated liquid under ordinary or reduced pressure. No vacuum pump was provided for

the first season's trials at Long Ashton and consequently the whole of the work was done under ordinary pressure: but there is no doubt that the reduced pressure method would give decidedly superior results both as regards quality of product, rate of yield, and cost of evaporation. For future work in this direction it is strongly recommended that it should be adopted. Another improvement which should in future be incorporated is the pre-heating of the juice before it enters the evaporator. This can be done by a simple addition to the apparatus, by which the heat of the evaporated steam given off by the juice is utilised for raising the temperature of the ingoing juice to boiling point, no addition to the cost of concentration being therefore entailed. Its effect would be in the same directions as those gained by working under the reduced pressure system. A single trial carried out in a rough way towards the end of the season demonstrated this fully.

Method of Making Jelly.—The general method of making the jelly has already been outlined. The actual details of the process, as generally carried out, are appended.

Type of Fruit.—Beginning with the fruit itself as representing the starting point, it is hardly possible to over-emphasize the importance of following as closely as practicable the procedure here laid down in connection with it. The quality of the final product and the yield depend very largely upon it.

The fruit to be dealt with should consist mainly of sweet or bittersweet varieties or a mixture of both types. A limited proportion of sour apples in the mixture is permissible, but it should in no case exceed one-third of the total quantity and not more than one-sixth should be allowed if the jelly is made without added sugar. The object is to secure that the percentage of malic acid in the finished jelly shall range somewhere between 1 and 1·5 per cent. The exact amount desirable is a matter of taste; for most palates, an amount below 1 per cent. results in a jelly too insipid and sickly sweet in flavour, while anything exceeding 1·5 per cent. is too sharp. It is obvious that the degree of acidity requisite in the unconcentrated juice must depend upon the extent to which the concentration is to be carried, *i.e.*, upon the percentage of sugar. Approximately 65 per cent. of total sugar is needed in the jelly: hence the quantity of sugar in the juice before evaporation, whether natural sugar only or natural plus added sugar, determines the extent of concentration required. At Long Ashton it was the practice to test the acidity and the sugar content of every lot of juice used, adjusting the acidity to the calculated quantity needed by the addition of sharper or less acid juices as the case might be.

In purchasing the fruit both for Wedmore and Long Ashton it was specified that sweet and bittersweet varieties only should be supplied, it being anticipated that a sufficient number of sour apples would be accidentally admixed to yield the correct degree of acidity in the juice. This anticipation was to some extent justified by results, but at times it was found that the addition of a further quantity of acid apples was necessary, and in such cases advantage was taken of stocks of such fruit which had been procured for pulping.

Condition of Fruit.—The correct blend of fruit or juice having been indicated, a few notes as to the state of ripeness at which it should be dealt with are desirable. The two principal points involved in this connection are (*a*) the yield of juice obtainable, and (*b*) the "setting" quality of the juice. Both are obviously highly important in connection with the commercial aspect of the manufacture of the jelly.

Experience in the making of cider has shown that the yield of juice is determined by the condition of ripeness of the fruit at the time it is milled and pressed. Both unripe and over-ripe fruit—particularly the latter—yield less juice from a given weight of apples than fruit which has reached a well-ripened condition. In practice it is impossible in dealing with large quantities of fruit to ensure either an even state of ripeness in each lot handled or the extraction of the juice in every case at the moment when it is capable of giving the biggest yield: but the influence of this point on the financial results is sufficienty marked to make it important to organise supplies of fruit in such a way as to enable them to be dealt with as far as possible while at the best condition of ripeness.

The "setting" quality of the juice is similarly much affected by the state of ripeness of the fruit. The juice from unripe fruit sets less well after concentration than that from perfectly ripe apples and that from much overripe fruit is also apt to give trouble in this respect. Up to a point a certain amount of over-ripeness may assist rather than hinder the "setting" of the jelly, and it is probable that the fruit should be left over to a somewhat more advanced state of maturity than is desirable from the point of view of yield of juice if the maximum "setting" quality is aimed at. It is preferable, therefore, that the fruit should be thoroughly well matured before extraction of the juice, even if a portion is distinctly over-ripe, rather than it should be milled unripe, unless steps are taken to ensure good setting by the use of pectin extract, concerning which information is given below.

Extraction of Juice.—There are no points of particular importance

in connection with the extraction of the juice which require notice. The methods found most satisfactory in cider-making apply equally in this case.

Supplies of Juice.—In preparing quantities of juice for evaporation it is desirable to provide at one time no more than is required for one day's working of the evaporator. Juice more than 24 hours old is liable to show the beginnings of fermentation, particularly during the warmer parts of the season, and when this occurs its "setting" qualities suffer owing to changes in its pectin constituents. An attempt was made to overcome this difficulty by treating the juice with sufficient sulphur dioxide to arrest fermentation for a few days: but, although the juice can be retained fit for jelly-making in this way even for so long a period as a fortnight or more, the jelly does not "set" readily and the method cannot be recommended except for emergencies caused by an over-supply of juice. This is bound to occur from time to time owing to the necessity of milling without delay occasional stocks of apples showing serious signs of over-ripeness.

At the same time it is desirable to provide at the start of each day a sufficient bulk of juice to last throughout the day. If this is pumped into one large vat, it ensures that the whole of the day's output is of uniform character, a point of considerable importance since in dealing with separate small lots of juice from mixed fruit it is inevitable that appreciable variations will occur. At Long Ashton two blending vats, holding about 750 gallons each, were used, the contents of the two sufficing to keep the evaporator running for a working day of about 15 hours.

Standardising Acidity of Juice.—The acidity of the supply of juice provided is brought to the required standard by blending as already described. It has been shown that this standard is determined by the degree to which concentration is to be carried, *i.e.*, according to whether sugar is or is not added. As mentioned in the beginning of this report, the method found most advantageous is to raise the content of total sugar in the unconcentrated juice to approximately 20 per cent. by the addition of cane sugar or corn syrup or a mixture of both, in which case the standard of acidity is taken as about ·35 per cent. of malic acid and concentration is carried to about 2/7ths of the original volume.

Use of Sugar.—When supplies of sugar in some form are available, its use is advised for the reasons already given. If cane sugar is exclusively used, the flavour of the jelly is sweeter and its consistency generally firmer. Corn syrup alone, consisting of a mixture of glucose, maltose and dextrin, yields a less sweet article

and there is a tendency for the jelly to show a more sticky or treacly consistency. A mixture of cane sugar and corn syrup in equal parts gives results little, if any, inferior to cane sugar alone.

Jelly made without added sugar is more intense in flavour, its colour is deeper, and particular care to avoid caramelisation during the making is necessary. It is, however, possible to make a palatable article without added sugar; and the only serious drawbacks to this method are that the yield of jelly from a given weight of fruit is considerably less and that when the price of apples is about £3 per ton or upwards the cost of the jelly works out at a slightly higher rate than that resulting when added sugar is used. The latter point simply resolves itself into a question of relative prices of apples and sugar.

In using added sugar or corn syrup special provision has to be made for dissolving this material in the juice. When it is added directly to the juice in bulk a serious loss of time occurs owing to the very slow rate of solution at the low temperatures prevailing during autumn and winter. Corn syrup especially is difficult to deal with in this respect. Hot juice quickly dissolves both cane sugar and corn syrup, but the bulk of juice required for the day's working is too large to permit of preliminary heating simply to dissolve the sugar, on account of the expense attached. An easy method of effecting solution and the one adopted at Long Ashton and Wedmore is to heat the quantity of sugar required with a comparatively small volume of juice in a steam-jacketed jam-boiling pan. Very little time is needed for complete solution. When the whole of the sugar is dissolved, the thick syrupy liquid is pumped into the main body of cold juice and thoroughly mixed with it by stirring. The jam-boiling pans can be heated with waste steam from the evaporating plant and no additional cost is involved.

At the beginning of the season the question as to whether it is better to add the sugar before or after concentration of the juice was given attention. The chief point in favour of the latter course is that less steam is required for concentration. It was found, however, that it was not easy to dissolve the sugar and obtain an even mixture in the thick syrupy concentrated liquid, and consequently the simpler method of addition before evaporation was adopted.

Use of Pectin Extract. There remains one further point to be dealt with before passing on to details of evaporation, viz., the steps which have to be taken to ensure the satisfactory "setting" of the jelly after concentration.

The investigations on pectin compounds which have been

conducted at Long Ashton during the past four years have shown that the following three conditions are necessary for a proper "gel" formation: (*a*) the content of total sugar present in solution—whether cane sugar, glucose, or some other suitable carbohydrate, either singly or in mixture—must approach 60–65 per cent.*, (*b*) an acid of some kind, preferably malic, citric or tartaric, must be present in quantity approximating at least to the equivalent of 1 per cent. malic acid, and (*c*) a suitable form of "pectin" must also be present in quantities of ·5 per cent. or upwards. In many samples of apple juice dealt with in the course of this work, with the acidity raised to the standard adopted as being most suitable for jelly-making, these three essential conditions were easily obtained in the finished product when the fruit handled was in reasonably uniform condition as regards ripeness and was milled when well ripened. Even when the fruit was somewhat over-ripe no serious trouble was experienced; but badly over-ripe fruit as well as unripe or unevenly ripe samples caused uncertain results mainly on account of pectin deficiencies. Since in practice the condition of the fruit generally is very variable, it was considered advisable during the greater part of the season to add a limited quantity of a pectin extract to the juice before evaporation.

The extract was made by passing waste steam from the evaporator into a mass of pressed apple pomace, plentiful supplies of this being, of course, always available. After being steamed for some time the mass was placed under the press and as much liquid as possible extracted. This fluid, which was thick and mucilaginous in character, contained considerable quantities of pectin and was added to the juice at the rate of 15 gallons of extract to 100 gallons of juice. When this method was adopted, the jelly could be relied upon to set well, provided that the juice was not overcooked in the evaporator.

With the extract an additional quantity of sugar was used (15lbs. of sugar to 15 gallons of extract) to avoid dilution of the juice in respect of that constituent.

The use of a crude pectin extract prepared in the manner described is mainly for the purpose of ensuring the proper "setting" of the jelly: but it also affects the yield from a given weight of fruit. Practically it amounts to the addition of 15 per cent. to the volume of the fresh juice handled with a corresponding gain in the final amount of jelly. It occasionally results in a still greater increase

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*** It has recently been found that a definite "gel" can be obtained with dextrin in place of sugar. This fact is of significance when corn syrup is used. A 30% solution of dextrin is capable of yielding a firm jelly.**

in the yield of jelly, since some juices without it have to be concentrated to a smaller bulk than that normally requisite in order to give a sufficiently firm " set." The question of cost of production does not appear to be materially affected because, although a ton of fruit will yield a higher percentage of jelly, an increased amount of sugar is used. The daily output of the evaporator is substantially the same whether the juice contains added pectin extract or not. On paper jelly with added pectin should be produced rather more cheaply, but in a limited trial made at Long Ashton this anticipation was not realised. Further tests, however, must be made before a definite conclusion can be drawn.

Some preliminary experiments with an improved form of pectin preparation suggest that an appreciable reduction in the cost of production should be possible, provided that the value of sugar as compared with that of the fruit does not vary materially from the ratio obtaining during the 1917 season. The preparation in question also promises to simplify the problem of making the jelly set and to yield a superior product.

From the point of view of flavour the addition of the pectin extract has no pronounced effect. The strength of the flavour is very slightly reduced, so slightly as to be practically inappreciable. The acidity is also slightly reduced, but this can be very simply adjusted by modifying the standard of acidity in the unconcentrated juice by suitable blending.

Clearing of Juice.- The fresh juice as it is received from the press is a turbid liquid containing variable amounts of particles of apple pomace in suspension. The removal of the coarser particles is essential and is readily accomplished by straining the juice through a filter bag made of canvas or other suitable material of moderately fine mesh as it is pumped into the blending tank. By that means the juice, while still turbid in appearance, is freed fairly completely from suspended solid matter, the turbidity being mainly caused by pectin compounds in solution. A further filtration of the juice is arranged as it is fed to the evaporator, the end of the suction hose of the supply pump being covered with fine-meshed straining cloth.

The turbidity of the juice disappears almost entirely in the final stages of its concentration in the evaporator. This is believed to be due to the interaction of the sugar, acid and pectin contents, and the comparatively sudden change from opacity to relative transparency which occurs apparently at or about a given point of concentration is regarded as indicating that the " jellying " stage has been reached. In practice it constitutes a safe guide.

The jelly prepared in this way without more elaborate attempts

at clearing is semi-transparent when cold, a certain amount of haziness developing as it cools. Attention is being given to the preparation of an absolutely brilliant jelly: but it is doubtful if this can be produced without the use of a costly and elaborate filter.

Concentration of Juice. The forms of evaporator used at Long Ashton and Wedmore having already been described, comparatively little need be added here as to the details of concentration.

A supply pump provides a continuous flow of juice into the evaporator, the rate of which can be regulated as required. This is determined by the specific gravity of the concentrated juice. It is considered necessary that the jelly should possess a total sugar content of 60–65 per cent. to ensure adequate keeping and setting properties. This is equivalent to a specific gravity of 1·350 (or about 70° Twaddell) at 15°C., which corresponds to a density of about 60° Twaddell at the temperature of the concentrated liquor as it is collected from the evaporator (about 95°C.). The whole rate of working of the apparatus is therefore controlled by the specific gravity readings of the concentrated juice. They are taken at frequent intervals with a hydrometer, the standard gravity adopted being 60° Twaddell for the hot liquor. When the gravity reading is too low the rate of supply of juice to the evaporator is slowed down, and when it is too high the supply is increased.

There is another means of controlling the rate of concentration, viz., by regulation of the steam pressure of the evaporator, an increase in this pressure resulting in an equivalent increase in concentration.

By the combination of this method with that of regulation of the supply of juice it is not difficult with the Kestner apparatus to maintain the specific gravity of the concentrated liquor at any point required. Control is similarly obtained with the American type of evaporator used at Wedmore, but exact regulation is more difficult and closer and continuous attention is needed in this case.

Treatment of Concentrated Juice.—In view of slight variations in the specific gravity of the concentrated juice as it flows from the evaporator it has been found better to collect the liquor in a fair-sized wooden vat rather than to run it directly into the final receptacles. By doing so small temporary fluctuations in specific gravity have no material effect, since the specific gravity of the whole contents of the vat is adjusted to the required standard before the jars are filled, by making up with juice of a somewhat higher or lower gravity as may be required.

Receptacles.—As regards receptacles, two kinds have been used, viz., glazed earthenware jars and waxed papier maché pots. The

concentrated juice, when the latter are used, should be cooled to 65°C. or even lower before it is placed in them, to avoid melting the paraffin wax with which the vessels are rendered waterproof.

After the receptacles are filled the juice is allowed to cool and set to a jelly before covers are put on. The exposure of the surface of the cold jelly does not appear to involve any risk of trouble with mould growth subsequently. No sign of mould has ever been observed on the jelly, even in cases when the article has been left standing without any form of cover for over three years. Nor has any instance of fermentation been recorded. The keeping quality of the jelly is, therefore, probably exceptionally good.

Storage.—The only point in connection with the storage of the jelly which requires mention is that an atmosphere as dry as possible is preferable until the jars have been finally covered down. The jelly is in some cases slightly hygroscopic, probably on account of the presence of laevulose (fruit sugar). It consequently absorbs moisture slowly in a damp atmosphere and the surface becomes slightly liquid. This soon passes off when the jars are placed again in a dry room.

Statistics.—Owing to delay in getting the plant fixed at Long Ashton and Wedmore it was not possible to start serious work at either place until towards the end of October: and then the first fortnight or so was largely occupied in working out the best methods of procedure. However, a sufficiently long period of the apple season was available to enable satisfactory statistics as to the capacity of the machines and the cost of production to be obtained.

Output.—As regards output the Kestner evaporator at Long Ashton was capable of dealing with 100 gallons of the prepared juice per hour under fair average conditions of working, giving an average production of about 275lbs. of jelly per hour. Under specially favourable conditions the quantity of juice per hour used advanced occasionally to 110–120 gallons. These figures refer to cold juice only In a trial where the juice was pre-heated to 75°C. before entering the evaporator the juice supply per hour easily reached 125 gallons. Probably an appreciable increase in these figures would have been recorded, had a larger steam boiler been available. That used had to be run at full capacity the whole time in order to maintain the steam pressure in the evaporator near 30lbs. per sq. inch.

The evaporator at Wedmore was considerably inferior in capacity, dealing with not more than 30–40 gallons of juice per hour, with a production of 80–100lbs. of jelly per hour. In this case, the juice was pre-heated in a special chamber of the apparatus before passing to the evaporator proper, and the working steam pressure in the

latter was about 80lbs. per sq. inch: so the greater efficiency of the Kestner type of machine is clearly demonstrated.

The total output of jelly for the season at Long Ashton was approximately 156,000lbs., and at Wedmore 56,000lbs., representing a weight of approximately 350 tons of apples dealt with at the former station and 210 tons at the latter.

Finance.—The accounts for the season's working not being yet complete and further expenditure still being incurred in connection with the packing and consignment of the produce, it is not possible at present to furnish a complete financial statement. A fair idea of the actual cost of manufacture of the jelly can, however, be given. At Long Ashton, on account of cider-making being in daily progress there, no separate records of the cost of milling the fruit and extraction of the juice could be kept; but calculations based upon the average price of the fruit for the season, the daily output of juice and cost for power and labour showed that a charge of 6d. per gallon for juice supplied to the evaporator would fairly meet the case. At Wedmore, since the jelly-making work only was in hand it was possible to get a series of actual figures for the yield of juice and the cost of milling and pressing; and the exact cost per gallon of juice supplied to the evaporator was thus obtained. To those interested in the question from a commercial point of view the Wedmore figures are unfortunately of little real value, since the mill and presses were not of modern type and gave a low yield of juice at a very high cost of production, and in addition the evaporator used was considerably inferior to the Kestner type as regards cost of production of jelly as well as of quality of product. No useful purpose, therefore, would be served by consideration of the Wedmore statistics in detail. The actual average cost of juice per gallon supplied to the evaporator worked out there at approximately 7d.

The cost of conversion of the juice into jelly fluctuated somewhat at both centres at different periods of the season, and also varied appreciably from day to day. To a considerable extent this was doubtless due to variations in the quality of the juice, but the opinion of those working the machines regularly was that the rate of evaporation and, therefore, its cost were materially affected by atmospheric conditions.

To obtain, therefore, a fair idea of cost of production of the jelly it is necessary to take the statistics for the season as a whole. Even then the result is open to a certain amount of criticism, firstly, because the whole season's work was necessarily somewhat experimental and costs accordingly were higher than they would otherwise have been and, secondly, owing to the relatively late date of

starting work, the main output was produced in the latter part of the season, when, as experience showed, the cost of production rises, on account of natural causes.

The accompanying table A, showing the Long Ashton statistics for the season up to January 3rd, 1918, when jelly-making ceased, is the most complete which can be given until the jelly is finally disposed of. It should be noted that it does not include management and establishment charges nor costs in connection with packing or railway carriage. Corresponding statistics for Wedmore are not yet available.

TABLE A.

PARTICULARS OF COST OF MATERIALS AND WAGES FOR MAKING 156,246LBS. (147,056 POTS OF 17OZS. EACH) OF JELLY.

	£	s.	d.
Juice and Pomace Extract	£1,416	13	3
Sugar and Corn Syrup	1,299	18	4
Pots	658	0	2
Wages (Total to January 3rd, 1918) ..	188	8	2
Coal	138	14	3
Jam Covers and Miscellaneous Materials ..	82	16	10
	£3,784	11	0

This figure works out to 5·81d. per lb.

Table B gives corresponding particulars for two individual weekly periods, and Table C for the daily results during a single week.

TABLE B.

SUMMARY FOR WEEK ENDING	November 24	December 1
Juice used	5,208 gals.	7,080 gals.
Cost of Juice..	£130 4s. 0d.	£177 0s. 0d.
Cost of Pomace Extract added in proportion of 15% ..	£1 9s. 2d.	£1 18s. 6d.
Sugar used	2,377lbs.	2,908lbs.
Corn Syrup used	3,785lbs.	4,739lbs.
Cost of Sugar and Syrup ..	£128 7s. 6d.	£159 6s. 3d.
Labour	£9 18s. 6d.	£11 14s. 0d.
Coal (estimated)	£10 1s. 6d.	£10 1s. 6d.
Pots filled	14,559	18,696
Cost of Pots	£60 13s. 3d.	£77 18s. 0d.
Total cost of materials & making	£340 13s. 11d.	£437 18s. 3d.
Output	15,469 lbs.	19,862 lbs.
Cost per lb.	5·285d.	5·34d.

TABLE C.

STATEMENT SHEWING PRODUCTION OF APPLE JELLY AND COST THEREOF FOR WEEK ENDING SATURDAY, NOVEMBER 24TH, 1917.

	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.	Total.	Daily Average.
Gallons of Juice used ..	677	877	918	900	910	926	5,208	868
Cost of Juice @ 6d. per gallon ..	£ s. d. 16 18 6	£ s. d. 21 18 6	£ s. d. 22 19 0	£ s. d. 22 10 0	£ s. d. 22 15 0	£ s. d. 23 3 0	£ s. d. 130 4 0	£ s. d. 21 14 0
Cane sugar used (in lbs.)	272	339	424	442	450	450	2,377	396·16
Corn Syrup used (in lbs.)	522	670	791	593	595	614	3,785	630·83
Cost of Sugar and Syrup @ 5d. per lb.	£ s. d. 16 10 10	£ s. d. 21 0 5	£ s. d. 25 6 3	£ s. d. 21 11 3	£ s. d. 21 15 5	£ s. d. 22 3 4	£ s. d. 128 7 6	£ s. d. 21 7 11
Cost of Pomace Extract used in proportion of 15%	s. d. 3 9	s. d. 4 11	s. d. 5 2	s. d. 5 1	s. d. 5 1	s. d. 5 2	£ s. d. 1 9 2	s. d. 4 10
Labour	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 9 18 6	£ s. d. 1 13 1
Coal (estimated) ..	1 13 7	1 13 7	1 13 7	1 13 7	1 13 7	1 13 7	10 1 6	1 13 7

TABLE C—*continued.*

	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.	Total.	Daily Average.
No. of Pots ..	2,007	2,372	2,644	2,472	2,518	2,546	14,559	2,426·5
Cost of pots @ 1d. ea.	£ s. d. 8 7 3	£ s. d. 9 17 8	£ s. d. 11 0 4	£ s. d. 10 6 0	£ s. d. 10 9 10	£ s. d. 10 12 2	£ s. d. 60 13 3	£ s. d. 10 2 5
Total cost of materials and making ..	£ s. d. 45 7 0	£ s. d. 56 8 2	£ s. d. 62 17 5	£ s. d. 57 19 0	£ s. d. 58 12 0	£ s. d. 59 10 4	£ s. d. 340 13 11	£ s. d. 56 15 7·83
Output in lbs. of Jelly	2,133	2,520	2,809	2,627	2,675	2,705	15,469	2518·16
Cost per lb.	5·1d.	5·37d.	5·37d.	5·29d.	5·257d.	5·28d.	5·285d.	5·277d.

Investigations on Apple Stocks.

The work on this subject, which has been in progress since 1913, has been previously referred to in the Annual Reports since that date, and some idea of the objects of the investigation, the nature of the problems and the directions in which the results were tending has been given. During the course of the past year a point has been reached which may be considered as marking the completion of the first stage of the investigation. The large numbers of stocks originally collected for examination at the start of the work have been under close observation during the intervening years, and it has now been possible not only to arrive at definite conclusions as regards the different types or classes of stocks which occur, but also to select standard examples of each type for propagation and future study. During the next few years the propagation of the selected individuals will constitute the chief item in the programme of work and probably little of material interest to report upon will arise in that direction. The final stage of the investigation and its ultimate aim will be reached when these individuals are propagated in numbers sufficient to permit of comparative trials of their respective merits as root-stocks at a number of centres throughout the country.

The present, therefore, seems to be a satisfactory time to review in some detail the results of the work up to the completion of the first stage. The following account does not purport to be more than a summary of results, since it is intended to publish a full illustrated report shortly.

The investigation was started because it was recognised that the whole basis of research on the culture of apple trees ran the risk of being unsound until the possible effect of root-stock influence was elucidated. Every tree except seedlings is worked either on the Paradise, free, or so-called crab stock, various strains of Paradise stocks are being used by different nurserymen, and every free and crab stock utilised represents a distinct individual, no two being absolutely identical. Granting the possibility of root-stock influence, it is evident that the results of every cultural experiment with apples can be vitiated by differences in the root system of the individual trees concerned, unless due precautions are taken to ensure the use of the same root-stock throughout. The latter can be arranged readily enough in the case of Paradise stocks by using only root-stocks from the same original stool; but hitherto all work with trees on crab and free stocks must be regarded as open to suspicion because all such trees have been worked on different individual

seedlings. To overcome the latter difficulty, when the first nursery was established at the Institute in 1904 a selection of ten free stocks of fairly distinct types was made and these have been propagated as freely as possible since. Trees worked on these stocks of known history are being used for experimental work in the Institute plantations at the present time.

When increased facilities for research in fruit culture became possible in 1912 by the allocation or specific grants for the purpose from the Development Fund, resulting in the extension of the work at Long Ashton and the establishment of a new experimental centre in connection with the South-Eastern Agricultural College at East Malling in Kent, it was decided to undertake an exhaustive investigation on root-stock influence at the two places named. It was arranged that the examination of the various strains of Paradise stocks should be conducted at East Malling, while similar work on free and crab stocks was to be taken in hand at Long Ashton. The present article is only directly concerned with the latter work, a very complete account of the results of the Paradise stock investigation having recently been published by Mr. R. G. Hatton in the Journal of the Royal Horticultural Society.

The primary objects of the investigation, stated in order of sequence, were :—

(*a*) to obtain detailed information as to the characters of the various root-stocks used in apple culture,

(*b*) to examine the nature and extent of the influence of the respective types of root-stock, and

(*c*) to select, with the view of their ultimate adoption as standard types in the fruit-growing industry, the forms which offer most promise for the various kinds of trees (standard, bush, cordon, etc.), the varieties of apple worth serious consideration as commercial sorts, and the different types of soil and situation adapted for apple culture.

The importance of the investigation lies not merely in its bearing upon the problems of apple culture ; it may be expected to throw light on some of the general questions common to all plants which are propagated by budding or grafting. That there is such a thing as root-stock influence cannot be doubted by thoes who have had practical experience with various forms of stocks ; but, although in the cases of a few plants a certain amount of information has been acquired, generally speaking the existing knowledge of the subject as a whole

is exceedingly limited. Mr. Hatton in his paper referred to has shown how lacking in precision was the knowledge of the various Paradise stocks prior to their study at East Malling. To a much greater degree a corresponding statement may be made as regards the free and crab stocks.

Without attempting to consider the matter in detail it is perhaps desirable to specify briefly some of the ways in which root-stock action may be involved.

Firstly, since the root-system of a plant is that part of its organisation which is concerned with the absorption of all food material other than carbon dioxide, it is evident that questions of nutrition, the nature and quantity of the various elements of food supplies, and, incidentally, the water supply, are concerned. Thus not only the general health of the tree but also such other points as vigor of growth, fruitfulness, and quality of fruit may be affected : probably, too, longevity. There is reason to believe also that the degree of susceptibility to certain fungoid diseases, *e.g.*, canker caused by *Nectria ditissima*, is to some extent dependent upon the nature of the root-stock.

Another important direction in which the root-stock is directly concerned is that of the physical character of the soil in relation to the plant. It will be shown in due course that in the case of apple stocks there occur all types of root-systems between the coarse, tap-rooted, sparsely branched type, practically devoid of all fibrous rootlets, and the type which consists of a mass of fine fibrous roots with an almost complete absence of strong roots. It stands to reason that a soil of a given physical character may be admirably suited for one type and quite unsuited for another. Heavy soils, for example, are generally regarded as adapted for the growth of plants with strong coarse roots and light soils for those with abundant fibrous roots.

Still another point of possible importance, and one in which there appears to be little known definitely at present, is the season of active growth of the stock. It has been observed that some stocks start into growth decidedly earlier in the spring than others, and similarly there are differences in the time of cessation of growth in the autumn. How far such differences affect the variety worked upon them remains to be seen.

From this short review it is evident that the question of root-stock influence is one which may have a very considerable bearing upon the behaviour of the tree and which must be taken seriously into account in any work on apple culture.

Kinds of Stocks.—At present the kinds of root-stocks used for

apples are generally grouped into three classes, viz., Paradise, free and crab-stocks. It is not proposed here to enter into any discussion as to the origin or relationships of these classes. Expressed broadly the main distinctions between them are usually regarded as follows :—

Paradise stocks are more or less markedly fibrous in character, mainly surface-rooting with a few coarse deeply growing tap roots, and reputed to exert a dwarfing effect on the growth of the tree and to induce early fruiting. (Mr. Hatton's article shows how erroneous some of these ideas are in the case of certain of the so-called Paradise stocks.) They are readily propagated by layering, and are used under ordinary circumstances only for bush, pyramid, or cordon trees.

Free stocks are simply seedlings obtained from the seeds of any cultivated kinds of apples. In practice they are raised almost exclusively from seed of cider apples. Propagation by layering is not considered worth attention and is not practised in their case in commercial work, since in the average case, unlike Paradise stocks, they do not root readily. The root system is generally of a coarser, less fibrous type, encouraging growth but delaying fruiting: and for that reason they are used mainly for the stronger types of trees, such as standards and half-standards.

Crab stocks also are seedling and not layered stocks, the reputed distinction between them and free stocks being that they are raised from seeds of wild-growing crab apples. In general the root-system is supposed to be similar to that of the free stock, but the crab-stock has always been credited with imparting greater hardiness to the tree.

In the following account of the investigations at Long Ashton no attempt has been made to treat the crab and free types separately or to differentiate in any way between them. The work up to the present having been concerned exclusively with the morphology of the root-system, there has so far been no need for separate treatment. There are no essential differences in the root forms of these two classes, and it remains for the future to show if there are actually the reputed differences in hardiness.

Although the Paradise group of stocks does not come under detailed consideration here, it must not be inferred that this indicates that they are regarded as a distinct and unrelated class. On the contrary, it is desired in this article to emphasize the view that there is at the present time no material distinction from the botanical side which can be drawn between the three specified groups of stocks. In all probability the present-day forms would show,

if it were possible to trace back their history, the same original group of common ancestors : and it is believed that the correct way of regarding them is simply as a series of hybrid varieties produced by much natural inter-crossing between, in the first place, the botanical species from which the ordinary cultivated apple has arisen and later, the varieties resulting from the earlier natural hybridisation. In a word, it is thought that they have a more or less common history and that the system of grouping generally adopted is based rather on chance morphological resemblances than on natural relationships. If this view is right, it follows that every Paradise form and every free and crab-stock, while definitely related, yet represents a distinct individual seedling with a separate parentage of its own and a combination of characters determined by the nature of that parentage. The problem of stock influence then, reduced to essentials, becomes this. Is the action exerted merely mechanical in nature and regulated by the morphology of the root-system, or is there definite physiological influence, the nature of which is determined by the character of the seedling ? So far as the present investigation has proceeded, it is rather on the morphological side that attention has been concentrated; but as the work develops in the later stages it should be possible to see to what extent the other side must be taken into consideration. It need hardly be pointed out that if physiology as well as morphology comes into play the whole position is enormously complicated. On the other hand, the possibilities of striking developments in the culture of the fruit are equally increased.

Free and Crab-Stock Types.—The large collection of free and crab-stocks at Long Ashton which had been examined and classified in 1914 and 1915 was again examined in March, 1917. Several hundred stocks which were originally obtained as "one year transplanted stocks" were carefully classified according to the character of their root-systems, and it was found that eight or nine fairly definite types could be distinguished. In many cases, of course, there was some doubt as to which of two types a stock resembled; but as the classification was necessarily only approximate, no classification according to actual measurements being feasible, slight variations from type are of no importance.

The whole of these stocks, therefore, were placed in one or other of the nine classes which it was decided were fairly definitely recognizable.

When all the "transplanted stocks" had been classified a few of the most typical and promising of each class were selected for

propagation and the remainder were discarded. The collection of free and crab stocks from various nurserymen which had been grown for the last four years, and which had received similar treatment in the way of lifting, examination, re-planting and earthing up, was then examined. The same course was taken with stocks obtained as seedling free stocks and with stocks raised from seed of the Paradise apple. In all these cases no complete classification was attempted, but the roots were examined to see if any fresh type could be found. However, no fresh type of root-system was found, though a number of very good examples of the typical classes were found and these were added to the selection of types. In all, about 60 plants have been selected from the whole number of stocks examined and these have been planted out and will be available for future investigations.

A general description of the characters of each type of root-system is given below, the only point noted about the stem being the degree of vigour of growth :—

Class A.—A mass of fine fibrous roots, practically no coarse roots. Stem usually distinctly dwarfed.

Class B.—Similar to A but with a few coarser roots. Stem slightly more vigorous.

Class C.—Numerous moderately strong horizontal lateral roots bearing much fibre. Fairly strong growth of stem.

Class D.—Very numerous weak or moderate laterals which have a distinct downward habit of growth. Less fibre than C. Stems variable but usually fairly strong.

Class E.—Similar to D, but laterals somewhat less numerous. Strength of stem about equal to B.

Class F.—Numerous strong horizontal laterals with fair amount of fibre. Strong growth of stem.

Class G.—Horizontal laterals stronger but not so numerous as in F; less fibrous than F. Original tap and lateral roots fairly active. Strong stems.

Class H.—Original root-system persistent, little adventitious rooting.
- (*a*) Stem strong.
- (*b*) Stem dwarfed.

Class J.—Similar to H, but adventitious roots almost absent.
- (*a*) Stem strong.
- (*b*) Stem dwarfed.
- (*c*) Suckers on roots.

It must be noted that all these stocks had been cut down in 1915 and earthed up for two years to form stools for the purpose of propagation, and that all the roots referred to above are adventitious roots springing from the base of the old stem except where they are definitely described as "original" roots.

In classes A to F the original roots had apparently entirely ceased to grow and to have any effect on the growth of the stock, the plant depending entirely on the adventitious roots above.

It has yet to be seen whether the root-system of a stock which had grown for the same number of years without being earthed-up would be similar to that of an earthed-up stock of the same kind.

From the above description of the nine classes of root-system recognised it will be seen that there are two extreme types with transitional types between them. In stocks of Class A there are no coarse tap or lateral roots, but the whole root-system consists of fine fibres, while the stem is usually dwarfed. In Class B coarser roots appear among the fibres and the stem is slightly stronger. Then the stocks in Classes C to G show successively fewer fibres and an increased tendency for the roots to consist of strong laterals, until in Class G there are found practically no fibrous roots but a small number of very strong laterals. Stocks of Class H are still strong in growth, but seem to depend mainly on their original roots, there being few adventitious roots and very little fibre anywhere. Class J contains stocks which are dwarfed and which bear no fibrous roots and no adventitious roots.

It is thus seen that there are dwarfed plants at both ends of the series, those in Classes A and B being due, apparently, to the almost entirely fibrous character of the roots, and those in Class J to the absence of any except a few poor tap-roots.

The non-formation of adventitious roots distinguishes Classes H and J from the rest, but it is possible if stocks were grown in the normal way, without earthing up, that the roots formed would resemble the non-adventitious roots of stocks of other classes grown under similar conditions.

For practical purposes the stocks may possibly be divided into only three types, assuming that Classes H and J would produce only non-fibrous tap-roots under all conditions. In Type 1 would occur Classes A and B, where the root-system is almost entirely fibrous and the plant is dwarfed in growth. Type 2 would contain all the intermediate classes from C to G, the roots being mainly laterals of greater or less strength with a varying amount of fibre. It is possible that this type would have to be sub-divided, as Classes

D and E have laterals with a downward tendency, while Classes C, F and G have horizontal laterals.

The third type would consist of Classes H and J, the non-fibrous tap-rooted stocks without laterals, the stem growth being either strong or weak.

It is certain that these three main types can be readily distinguished, while it is rather doubtful whether the smaller divisions always represent real differences. Thus, stocks in Classes D and E have very similar root-systems and it is possible that the roots of one such stock might vary between the D and E type according to the soil in which it was grown. Similarly Classes C, F and G all have roots of the same general type, the only differences between them being the slightly varying strength and number of laterals and the amount of fibre. It is conceivable that the roots of a stock might conform to any of the Classes C, F or G according to the conditions under which it was grown; but it is extremely unlikely that any change in the conditions of growth could induce such a stock to form a root-system of the A, B, H or J type.

It is also possible that stocks of Class J are really Class H plants which have only made weak growth owing to slightly different soil, moisture, or other conditions of growth. For the present, therefore, the free stocks may be divided into these three main types:—(1) fibrous rooted, (2) with lateral roots and some fibre, (3) with coarse tap-roots.

No record was made of the exact number of stocks placed in each class, but an approximate figure can be given for the proportion of stocks in each main type. About 1,200 stocks were retained for the final examination, and of these only about 2 per cent. were found to belong to the very fibrous-rooted Type 1. The intermediate Type 2 was by far the most numerous and made up about 90 per cent. of the whole number, while the remaining 8 per cent. belonged to Type 3. Considering the numbers of stocks dealt with and the widely different sources from which they came, it is probable that these percentages represent more or less the proportions of the different root types which would be found in any chance collection of free stocks.

It is evident that any collection of free stocks will probably include plants of widely differing root habit and that the effect on trees worked on these stocks may be correspondingly different. Up to the present time it has usually been assumed that all "free" stocks will produce the same kind of trees when worked with the same variety, but this assumption is not likely to be correct, since the root-systems of the free stocks differ so widely; and this doubtless accounts

for the actual difference which does often exist between individuals of the same variety worked on free stocks and grown under the same conditions. To secure uniformity in results when free stocks are used it seems therefore necessary to use stocks which conform to certain standards in their root-systems. This could be done if pure strains of stocks could be propagated by vegetative methods in the same way as Paradise stocks are propagated; and this subject will be referred to again later in this article. If, however, free stocks are to be raised from seed, as they now are, it must be considered whether it is possible to obtain with certainty a collection of stocks with roots of the same general type. In other words, can the nurseryman when raising his seedling stocks for transplanting classify them according to the type of root-system which they will develop when older? Does the root-system of a seedling give sufficient indication of the type of roots which will develop later, or will the type of root change as the stock grows older? This question can be answered to some extent by referring to the records of some of our stock examinations. All the stocks, as seedlings or "1 year transplanted stocks," were classified before planting early in 1914. In 1915 they were lifted and examined in detail again and this was repeated in 1917. A comparison of the notes made in each year concerning the various individuals shows how far the original classification holds good after another three years' growth. On the whole the stocks still show the same root characters which they had in 1914, though it cannot be said that young stocks can be classified with absolute certainty. Thus some individuals which in 1914 were classed as fibrous-rooting have since developed much coarser roots, while others then recorded as being lacking in fibre have now formed good fibrous root-systems. Perhaps some of these discrepancies are due to the difficulty of distinguishing between "fibres" and "weak laterals" when dealing with very young plants. Still, it seems possible to separate Type 1 from Type 2 with very fair accuracy when examining seedlings or 1 year stocks. The agreement between the classifications of 1915 and 1917 is even closer. But the distinction between Types 2 and 3 in the early stages was very often found to be wrong in 1917.

The most common type of free stock is Type 2, in which there is a strong-growing stem with numbers of moderately strong lateral roots which grow fairly near the surface of the ground. As this is the type of stock desired when a "free" stock is asked for, it is probable that considerable attention will be given to the production of stocks which can be relied on to be true to this type. But the

stocks of Type 1 are also extremely interesting and deserve description in more detail.

The roots of these plants consist of a mass of fibres, which in some cases are mixed with a few rather coarser lateral roots, while in other cases there are no coarser roots. The fibrous roots grow with remarkable freedom on the original root, and as adventitious roots from parts of the stem. The young stocks after examination early in 1915 were cut back and re-planted, and after fresh shoots had grown they were earthed up so as to cover the base of the young shoots: this earthing-up was continued until the next examination in 1917. In September, 1915, a number of these stocks which had shown signs of free rooting, were examined by scraping away soil from one side of the heap, the soil being moulded up again after the examination. In almost every case young roots were found on the stems, most frequently on the older part of the stem which had been cut down, but also often on the base of the new shoots of the current year. In 1917 the whole of the oldest part of the stem which had been covered with soil was often found to be a mass of fibrous roots, the original roots which had been deeply buried having ceased to be active. At this time, too, some of the new shoots and almost all those of the previous year were well rooted where they had been covered with soil. The stems of many of the stocks of Type 1 show swellings or knots from which roots readily spring if the stems are earthed up, and sometimes very short root-tips appear even on stems exposed to the air. These swellings, root-knots or burrs are precisely similar to those described and illustrated in Mr. Hatton's article on the Paradise stocks in the Journal of the Royal Horticultural Society for September, 1917.

The shoots of these stocks of Type 1 are usually distinctly less vigorous in growth than those of Type 2, and are sometimes much dwarfed, though apparently quite healthy; but recent examination of the stocks which have made a further year's growth in 1917 shows that some of them have made fairly strong growth this last year. The more or less dwarfed habit, the fibrous surface roots and the great ease with which stems root are all characters which have hitherto been considered typical of the Paradise stocks.

All the Paradise stocks now in use must originally have arisen as chance seedlings, and there is no reason why fresh stocks of the Paradise type equal, or possibly superior, to those now in use should not be found. It is quite possible that some "free" stocks of this Type 1 may be found to be more suitable for use as Paradise stocks than the existing Paradise types. In order to test this all the best individuals of the fibrous type which have been found are now

being kept for propagation so that their practical utility as stocks may be tried in the usual way.

Comparing photographs of some of these Type 1 free stocks with the illustrations of the Paradise stocks in Mr. Hatton's paper it certainly seems as though some of the free stocks are more free and fibrous in their rooting habits than many of the Paradise stocks.

No attempt has been made to classify or describe the stems and foliage of these stocks. As they are all raised from seed there are no two alike, being hybrids, and it would be quite useless to spend time in cataloguing their individual shoot characters. If any of them are found to be worth propagating vegetatively as definite varieties of stocks, then, of course, it will be necessary to make detailed descriptions of them in order that they may be identified in the future.

For the present it has been thought sufficient to note roughly the different stem and leaf types which occur. It has not been found that there is any correlation between different stem and root types: any type of stem may appear or any type of root. One important point to be noticed in choosing a stock for working purposes would be the "clean-ness" of the stem, that is, whether a young stem is unbranched or whether it is "feathered" with branches or spines. A clean stem is much more convenient for working on than a feathered one. Seedlings with stems which are more or less branched are the most common among the stocks examined and they may be either stout or whippy. The branches themselves also vary in length and in strength and in the number of spines they bear. The seedlings with clean growing stems are not so numerous, but there is a fair proportion of them. The chief differences between the various clean stems consist in the stoutness or whippiness and the length of the internodes.

Propagation—If pure strains are wanted of any free stocks, whether of the 1st, 2nd, or 3rd types, it is obvious that the stocks must be propagated vegetatively, and the question of the best method of doing this now arises. Propagation by stem cuttings has been tried at Long Ashton with a number of the stocks, but so far without any adequate degree of success. The possibility of propagation by this method must not be entirely ruled out, however. Numbers of root cuttings were also made in 1915 and from these a fair proportions of plant have been raised. With more experience of the most favourable conditions for the growth of root cuttings it is possible that this method might be of considerable use. Propagation by stool-layering seems, however, likely to be of more immediate service. All the

free stocks here have been cut down and earthed up with the intention of forming stools, as already described in the 1915 Report. In the case of stocks of Type 1, as mentioned above, shoots of the previous year, and sometimes of the current year, have rooted freely, and a number of new plants have been obtained by cutting off these rooted stems. There is no doubt that stocks of this type could readily be propagated by this method or any other method of layering. Stocks of Type 2 have also yielded numbers of new plants by this method, and it is probable that this method of propagation could be used successfully with nearly all stocks of this type. But usually it is only the one year old shoots and not the new shoots of the current season's growth which root in these cases.

The readiness with which stocks of both Type 1 and Type 2 form adventitious roots is most noticeable. Many Type 2 plants have formed very strong roots from the earthed-up portion of the main stem, so that the original roots have become functionless, while at the same time very strong shoots have formed. It is thus evident that sufficiently strong adventitious roots could be obtained on layers to enable the layer to grow strongly when detached from the parent plant. And, in fact, many layers separated from the stools in April, 1917, made good growth during the summer and now seem well established.

Stocks of the third type cannot be propagated by layering, or, only rarely, owing to the absence of the ability to form adventitious roots.

Constancy of Root Characters.—At the present stage of the investigations it is impossible to say how far the roots of an individual when grown under different conditions may vary from the type with which it is now classified.

As mentioned above, all the classifications have been made with stocks which have been transplanted several times and which have been earthed up for two years. These operations may have caused some modification of the natural rooting habits of the plants and it will be necessary to grow the selected stocks under the same conditions as they would be under if used commercially for stocks. Young rooted layers will have to be planted and allowed to grow for, say, four years without any cutting back, earthing-up or lifting for examination. At the end of that time the plants will be lifted to see if the roots formed under these undisturbed conditions conform to the type with which they were originally classified. If that is found to be the case stocks of desirable types can be propagated for practical use and their effect on grafts noted.

There is still the question to be considered as to how far stocks

propagated vegetatively may vary from the type of the parent plant, but there is good reason to suppose that no variation of consequence occurs under normal conditions.

The Cider Industry in Relation to Present Food Problems.

The following article would in normal times be out of place in its position here in the Report on the work of the Station not being a record of any particular investigations and only in part a medium for suggestions of turning results of previous experiments to practical account. Its inclusion may, however, perhaps be justified on the ground that the questions with which it deals are mainly urgent and closely concern all sides of the cider industry, while the Report of the National Fruit and Cider Institute is the most likely publication to reach those interested.

Some of the questions which arise are likely to be regarded as highly contentious, and expressions of opinion here offered must not be taken as the considered views of the National Fruit and Cider Institute as a body representing all sides of the industry, but simply as the personal ideas of the writer.

It is obvious that the present position of the cider industry is a very critical and difficult one. On the one hand, its opportunities were never greater. The restriction on the output of beer has resulted in a largely increased demand for cider and perry, and many who before the war were practically unacquainted with them have now become regular consumers. There is every opportunity, then, for establishing those beverages in a strong recognised position and all makers would naturally like to raise the standard of quality of their product to the highest possible point. On the financial side also there is every encouragement for the industry in spite of the taxation recently imposed on the articles. Under such circumstances the aim of the maker is a maximum output. On the other hand, it must be recognised that in a time of food scarcity it is at least debateable to what extent material of potential food value normally used for the production of fermented drinks can be justifiably utilised for such purposes, which result in the destruction of nutrient substances. This point has been already warmly contested in the case of beer and a definite limit on the use of barley in brewing has been imposed. Hitherto the matter has not arisen seriously in connection with cider and perry fruit. Until 1917 adequate supplies of fruit of all kinds for all dessert, culinary, and jam requirements were available and there was accordingly no occasion to draw materially on

supplies of cider and perry fruit. In 1917 it became clear that suitable fruit of any kind would be needed for jam production to carry on until the fruit season of 1918, and accordingly large quantities of sour cider apples were pulped for jam-making by the Fruit Preserving Section of the Food Production Department and the jam manufacturers. Also some 500–600 tons of sweet and bittersweet apples were converted into jelly, as already described in an earlier section of the present Report. The exceptionally heavy crop, however, prevented these calls on the supplies being felt by cider-makers to any serious extent. Looking forward to the coming season the position is altogether different. It is unlikely that there will be a heavy fruit crop. At the same time the need of fruit for jam and jelly making will in all probability be considerably greater. It may be presumed that the consumption of cider and perry will increase rather than diminish ; and there is, therefore, every likelihood of a situation arising in which there will be marked competition for supplies of fruit for cider and perry making and for food production respectively. For that reason it seems desirable to review the whole situation with the object of seeking a way by which the industry can assist to the fullest extent in the national emergency with the least possible detriment to its present position and future outlook.

In this connection it must be fully realised that the matter is not merely one of diversion of a certain tonnage of fruit from cider and perry making to jam and jelly making. The total crop represents the produce of approximately 100,000 acres of grass land in the West of England, and the fundamental question is to what extent this acreage is bearing or can be made to bear its fair share of the burden now laid upon all land fit for crop production.

Two more or less distinct subjects arise from this. Firstly, that of the manner of utilising the fruit to best advantage for present needs : and, secondly, that of dealing with the orchards so as to ensure a maximum return in crops of real value.

Dealing with the former subject first, it resolves itself very largely into a consideration of the question as to the extent to which cider and perry fruit should now be used for cider and perry making. It will be convenient to take the cases of sour or sharp fruit and the sweet and bittersweet varieties separately, not because both classes cannot be turned to advantage as food but chiefly because, while the former have always been regarded us utilisable for that purpose, it is only as the result of recent work that sweet and bittersweet fruit have been shown to be of value in that respect.

All sour apples of fair size can be used for culinary purposes quite

satisfactorily without any special treatment, while smaller specimens serve for jam and jelly making. So long as there is any demand for them for such purposes during the existing period of food shortage it is difficult to see how a strong case can be made out for their use in cider and perry making, if it can be shown that palatable and non-injurious forms of those beverages can be made without them.

During recent years at least the cider-maker has come to regard the use of a certain proportion of sharp fruit as indispensable, and with good reason, since a certain degree of acidity in the product is required both for flavour and also to prevent disorders such as sickness and ropiness. Without this degree of acidity the beverage cannot be relied upon to keep sound unless a preservative is added. But is it not possible to obtain the requisite acidity by other means ? At the present time, when the use of substitutes must be acknowledged to be justified and necessary in many forms of food and drink, rigid adherence to pre-war ideas as to what is or is not legitimate in cider and perry making cannot be maintained. For that reason it is suggested that sharp fruit should be replaced as far as may be necessary by suitable acids, such as citric or tartaric, or any of the non-injurious composite acid mixtures, such as are largely used to-day in the mineral water trade. Assuming that the juice dealt with was obtained exclusively from sweet and bittersweet fruit, this would in the average case possess a natural acidity of ·2—·3 per cent. malic acid and only an addition of ·3—·4 per cent. of one of the substitute acids specified would be required to give the product all that is necessary in the way of flavour and keeping properties. In the face of this it can hardly be maintained that sharp fruit must be used, and it certainly seems that the claims on supplies for jam-making and culinary purposes should receive first consideration.

It is only as the result of recent work at Long Ashton that sweet and bittersweet fruit comes up seriously for consideration from the food point of view. As described in the various Reports of this Station issued since the start of the war, it is now possible to use such fruit either for culinary or jam purposes or for jelly making. That being so, it may be argued on similar lines as above that the whole of this class of fruit also ought to be ear-marked as far as needed for food purposes. The only reason for attempting to draw any distinction between the position of this and that of sharp fruit is that the latter can be utilised for food directly without any special treatment, while the former requires suitable methods. However, the fact that it can be utilised means that the cider-maker may, like the brewer, have to be content with limited supplies. In that event how best could the situation be met ?

From the point of view of the welfare of the industry, more particularly with regard to its future position, it seems important that the supplies of cider and perry to the general public should as far as possible be maintained. In other words, attention should be concentrated on production for commercial purposes rather than for home use on farms. The practice of providing cider for farm labour has in many cases been abused, and recently there has been considerable controversy on the subject. Under the circumstances would not the best way out of the difficulty be for cider and perry to be made only for sale, except, possibly a limited quantity for use in the farmhouse itself? A small proportion for farm labour might, where desired, be reserved in addition, the necessary bulk being made up by heavy dilution with water. By some such method a considerable quantity of these products which never normally reaches the market would be available for the general public.

The other method of maintaining supplies which merits consideration is that of abandoning for the time being the production of pure-juice cider and perry,—except possibly in special cases—substituting for it a diluted form of beverage. A perfectly palatable and wholesome drink can be made in many cases simply by the addition of a limited quantity of water. In other cases, where the pure juice is too weak to permit of this being done satisfactorily, the best plan would probably be to bring up the specific gravity of the freshly pressed juice—after dilution with the desired amount of water—by the addition of the requisite quantity of corn syrup, adding also at the same time a suitable amount of one or other of the acids above specified if the degree of acidity was otherwise too low. Quantities of a lower-grade but palatable beverage could also be made on similar lines by extracting the pressed pomace with water and bringing the standard of the extract up to a suitable point of addition of corn syrup and acid.

By proceeding along the lines indicated the output of cider and perry for general consumption could be more or less well maintained with probably no serious detriment to the industry as a whole, and a very large proportion of the fruit crop would be available for food production.

There is no occasion here to go into detail as to the various uses to which this fruit could be put, these having been dealt with individually at some length in this and other recent Reports. They may be summarised as follows :—

Apples and pears of the sharp class :—

Jam and fruit pulp.
Culinary use.

Apples and pears of the sweet and bittersweet classes :—

Jelly (by the juice concentration method).
Apple and Pear Syrup (by concentration of juice).
Jam (by addition of acid).
Culinary use (by addition of acid).

The value of cider and perry fruit is not, however, exhausted with the various uses already specified. The pressed pomace is an article of material value and can be put to a variety of uses. These again have been enumerated in recent articles and need not be enlarged upon here. It is a useful food, wet or dried, for cattle and pigs, and every effort should be made by individual cider-makers to see that all not required for other purposes is put to use in this direction. It can be used for vinegar making, and with the prospect of a shortage of malt vinegar there seems a distinct opening both for inferior cider and perry and also pressed pomace for this purpose. It is also likely that next season means will be found to utilise it in jam making on a commercial scale, both for the production of pulp for jam and also as a source of pectin : and these uses may ultimately prove to be the most important. Finally the residues from the latter processes as well as the pressed pomace itself are of value as an organic form of manure.

Passing on now from the subject of utilisation of the fruit to that of the orchard problem its importance may be realised by reference to the most recent returns of the Board of Agriculture and Fisheries, which show that in the western counties there are approximately 100,000 acres scheduled as apple and pear grass orchards. By far the greatest proportion of this land is nominally occupied with cider and perry fruit ; but it must be borne in mind that many of these orchards exist in little more than name now, so few trees remaining and those so degenerate. But, making due allowance for that, it is clear that a large area of valuable land—for most of the orchards are located on really good soil—is taken up with cider and and perry trees, and it must be admitted by all who are familiar with the conditions that proper value is not being obtained from that land. Not only are many of the orchards now sparsely stocked with trees, and not only are a seriously large proportion of the trees worn out or crippled, but also many of the more vigorous trees are of absolutely inferior and almost worthless varieties. At an early date the question of the restoration and renovation of these orchards will have to be taken in hand and a definite movement in that direction may shortly occur. There is no occasion here to do more than outline the various lines of action which can be taken.

In the first place a thorough survey of the orchards is needed,

to show (*a*) which varieties are worth preserving and which should be discarded, (*b*) which orchards are worth restocking, and (*c*) which individual trees should be left untouched, which removed and replaced, and which re-worked with selected varieties of real commercial value. With this information available an organised programme of orchard improvement could be planned and carried out. Apart from orchard improvement the effort would almost certainly be thoroughly justified by bringing to light local or practically unknown varieties of real value.

In the second place efforts should be made to invigorate the existing trees. The majority at present are harbours for pests of all kinds, and as such are a serious nuisance for all serious fruit culture in the locality. A simple form of cleansing winter wash would yield results out of all proportion to the outlay and trouble necessitated. Again, the fact that the orchards are on grass land means that the trees are exposed to the injurious action which Pickering's experiments at Woburn and elsewhere have demonstrated to be exerted by the grass. While it may be admitted that this toxic grass effect varies considerably in extent in individual orchards,—the experimental work carried out by this Station has demonstrated this for the West of England—its existence must be regarded as established, and there are undoubtedly many trees in an unhealthy condition simply because they are planted in grass. In the case of comparatively young trees the removal of the turf for an area of from three to six feet radius around the base of the stem would cause frequently marked renewal of vigour. There are probably special cases where it would be profitable to cultivate a portion of or perhaps the whole orchard, growing a suitable food crop on the land thus provided. Where cultivation is out of the question attention should be given to the use of the orchards for grazing purposes. Improvements in the condition and quality of the herbage could in many cases be effected, and the result would be of mutual benefit to the stock fed thereon and also to the trees.

While these suggestions have to do with the trees themselves and only through them with future actual crops of fruit, much more could be made of the present crops of fruit produced. The quantity of fruit which is allowed practically to run to waste is far greater than need be in very many instances. A limited amount of loss of fruit in a grass orchard is possibly unavoidable: but no excuse for not attempting to harvest the crop in good condition should be allowed to hold when fair prices are obtainable. In spite of labour difficulties it has been possible to get in the fruit in good condition when the grower seriously attempted to do so : and, if supplementary

help is needed, local organisations for fruit picking and gathering can be arranged. The need for fruit will be such that any grower neglecting to harvest his fruit properly may run the risk of being penalised.

A great waste of fruit also commonly occurs after it has been collected. It is allowed to lie about the orchards or in store until over-ripe and frequently more or less rotten: and its value is accordingly largely depreciated both for cider-making and any other purpose. It must also be regarded as a waste of fruit when cider and perry inferior in quality to that which could be obtained by proper treatment is produced. Much of the cider and perry made on the farms falls under this head. In stating this there is no intention of decrying farm-made cider. On the contrary it is fully admitted that in certain cases some of the best and purest cider is made on the farm. Nevertheless, owing to a variety of circumstances it seems to be inevitable that a large proportion of farm-made cider is unnecessarily inferior in quality. The most promising suggestion of dealing with this form of waste appears to be the establishment of co-operative cider factories by the farmers in suitable centres. It is encouraging to find that this idea is meeting with support in several quarters and only the intervention of the war has prevented their establishment in certain centres.

In conclusion it is desired particularly to emphasize again the point that the time has arrived when the cider and perry orchards of the West of England must be dealt with. They represent far too large an area of land to be permitted to remain in their present unsatisfactory and relatively unproductive condition. The interests of the cider industry are so closely concerned that it is most important that its requirements should be clearly defined and recognised: unless this is ensured, it may find itself before many years have elapsed faced with a regular shortage of fruit. The suggestions put forward here for keeping up the output of cider are, of course, merely intended to tide over the present emergency and not to meet any permanent shortage of the cider fruit crop. The whole position needs most careful consideration and a considerable revision of present conditions and practice may be necessary for the future development of the industry.

A Joint Potato Variety Trial.

It has for some time been recognised that the hitherto prevailing system of conducting variety trials of agricultural and horticultural crops in this country has failed to yield results commensurate with

the amount of effort expended. This partial failure has been due primarily to the fact that in the great majority of cases there has been far too little co-ordination between individual trials of a similar character. Most institutions and other bodies conducting the trials have worked more or less on lines of their own, with the result that satisfactory comparison between individual trials has been rendered almost impossible. The establishment a few years ago of Provincial Advisory Councils throughout the country promised considerable improvement in this direction, but the war has for the time being curtailed their activities. However, at the Potato Conference at Ormskirk, under the auspices of the Board of Agriculture and the Lancashire Farmers' Association, in October, 1916, Mr. W. Cuthbertson, V.M.H., of the firm of Dobbie & Co., undertook to organise a potato variety trial under standardized conditions, and this was carried out in 1917 at ten centres throughout the country by the following :—

Professor Seton, The University, Leeds.
Dr. Keeble, F.R.S., Director, R.H.S., Wisley.
Mr. W. D. Davidson, Department of Agriculture for Ireland.
Mr. W. Mauger (Mauger & Son), Guernsey.
Mr. P. C. M. Veitch (Robert Veitch & Son), Exeter.
Mr. E. J. Deal (Johnsons, Ltd.), Boston, Lincolnshire.
Mr. Sowman, Lancashire C.C., Hutton.
Mr. G. T. Malthouse, Shropshire C.C., Shrewsbury.
Mr. James Bone (Dobbie & Co.), Edinburgh.

The tenth centre was at the Research Station, Long Ashton, the work there being under the charge of Mr. H. Locke.

Twenty varieties of potatoes were tested, twenty sets of each. The seed was as uniform in character as it was possible to obtain, having all been grown in a market garden near Edinburgh in 1916, and previous to that in various parts of Scotland. All varieties were grown in rows 3 feet apart and the sets placed 18 inches apart in the rows. The ground at each centre was prepared during the winter by being dug one spit deep and manured with farmyard manure at the rate of 20 tons per acre. All seed was boxed and sprouted prior to planting, the latter being accomplished by Easter, 1917. At the time of planting artificial manure on the basis of a 6 cwt. dressing per acre (1 cwt. sulphate of ammonia, 1 cwt. sulphate of potash, 4 cwt. 26% superphosphate) was applied in the rows. The precaution of planting one or two rows at each end of the trial plot with a variety not in the trial was adopted.

All seed and artificial manures were provided by Mr. Cuthbertson,

who also collected all information as to the results at the respective centres and prepared a report upon them which was recently published in the Journal of the Royal Horticultural Society (Vol. XLIII). The following details are taken from that report. Thanks are due to Mr. Cuthbertson for permission to use them and to the Royal Horticultural Society for sanction to reprint.

Before passing on to them attention may be more particularly directed to the comparatively uniform manner in which individual varieties stand in order of merit at the various centres and also to the striking yields of the first early varieties as compared with the second earlies and maincrops. Doubtless the weather was partly responsible : but it is evident that they are not always markedly inferior in yield, as many authorities assume. It will probably be generally agreed that the results thoroughly justify all the trouble taken by Mr. Cuthbertson, and fully bear out the view of the importance of standardization and co-ordination in trials of this character.

"*Nature of Soils, etc.*—The following particulars furnished by the growers will indicate the nature of the soils on which the potatoes were grown. The localities are given in the same order as in the table.

1. Guernsey. The soil is of a very sandy nature and has carried bulbs for many years. It was reclaimed from the sea in 1812, and up to twenty-five years ago produced little. When it came into the present possession it was drained and many thousands of loads of sandy road sweepings were added. It lies eight feet above sea level.

2. Edinburgh. Free loam on market garden land at Joppa, four miles east of Edinburgh.

3. Bristol. Sandy to medium loam, with a tendency to stickiness on surface after heavy rain and caking on drying, at Long Ashton, four miles west of Bristol, 160 feet above sea level. Followed nursery apples.

YIELD OF POTATOES IN LBS.

	Guernsey.	Edinburgh.	Bristol.	Leeds.	Wisley.	Boston Lincs.	Co. Down, I.	Exeter.	Preston.	Salop.	Total.
					EARLY VARIETIES.						
Sir J. Llewelyn ..	71	72	88	89	75	76	81	63	65	66	746
*Snowdrop (Resistant)	60	61	64	58	59	75	72	58	53	54	614
Sharpe's Express ..	55	63	66	64	58	77	66	48	54	55	606
Witch Hill	65	62	56	59	55	75	66	50	53	44	585
Midlothian Early ..	64	47	22	49	56	34	46	23	49	38	428

Yield of Potatoes in Lbs.

					Wisley.	Boston Lincs.	Co.Down, I.	Exeter.	Preston.	Salop.	Total.
Second Early Varieties.											
British Queen	90	87	87	80	87	94	79	78	54	63	799
*Great Scot	80	94	93	69	46	42	54	36	44	35	593
*Secundus	75	45	92	50	42	59	46	76	29	53	567
*Burnhouse Beauty	60	60	43	55	56	57	56	48	51	42	528
*Dobbie's Favourite	73	75	31	65	61	26	53	29	47	19	479
Main Crop Varieties.											
Dobbie's Prolific ..	115	79	65	54	74	66	63	61	53	38	668
*The Provost ..	64	79	90	52	71	70	52	70	48	54	650
The Factor	80	77	51	68	79	53	77	56	74	28	643
King Edward ..	48	68	88	71	67	80	61	50	30	38	601
*The Admiral ..	71	48	83	57	50	68	29	79	44	47	576
*Kerr's Pink ..	77	85	50	67	66	52	51	47	43	31	569
Arran Chief	45	54	40	59	61	52	55	77	55	34	532
Isis	59	65	55	59	52	55	39	44	47	23	498
*White City	36	56	46	58	62	56	44	56	44	30	488
*The Lochar	52	60	45	55	41	32	44	46	39	22	436
Total ..	1340	1337	1255	1238	1218	1199	1134	1095	976	814	11,606

* Resistant to Wart disease.

4. Leeds. Medium loam soil overlying coal measure sandstone, at Garforth Manor Farm, eight miles east of Leeds.

5. Wisley. Light sandy loam at junction of Bagshot sands and London clay, at R.H.S. Gardens, Wisley, Ripley, Surrey, 120 feet above sea level.

6. Boston, Lincs. Light top soil on heavy bottom.

7. Co. Down. Reclaimed mountain land which had previously grown nothing but bracken. A gravelly loam at Burrenreagh, Castlewellan ; soil as a rule very suitable for potato-growing.

8. Exeter. Dark stiff loam with a clay and gravel subsoil, at Eleve Nursery, Exwick, growing young conifers for past six years.

9. Preston. A hazel loam one year from pasture at Council Farm, Hutton, near Preston, 82 feet above sea level.

10. Shropshire. A medium loam containing a fair quantity of flinty stones. Old pasture bastard trenched early in 1917 at Oswestry.

The following table shows the weight of seed of each variety sent to each station :—

Weight of "Sets" sent to each Station in Lbs.

	Guernsey.	Edinburgh.	Bristol.	Leeds.	Wisley.	Boston Lincs.	Co. Down, I.	Exeter.	Preston.	Salop.	Total.
Early Varieties.											
Sir J. Llewelyn ..	2¼	2⅛	2½	2⅛	2⅛	2½	2¼	2½	2¼	2⅝	23⅛
Snowdrop (Resistant)	2⅝	2¼	2½	2½	2¼	2½	2¼	2⅝	2⅜	2½	24⅜
Sharpe's Express ..	2⅝	2½	2½	2¾	2½	2½	2¼	2⅝	2⅝	2⅝	25½
Witch Hill	2⅝	2¾	2½	2⅞	2⅞	2½	2⅞	2½	2⅞	2⅝	27
Midlothian Early ..	2⅝	2¾	2¾	2¾	2⅝	2⅞	2⅝	3	2½	2⅞	27⅜
Second Early Varieties.											
British Queen ..	2⅝	2⅞	2½	2⅞	2⅞	2⅝	2⅞	2½	3	2⅝	27⅜
Great Scot	3¾	2¾	3½	2½	2½	3	2¼	3½	2½	3¼	29½
Secundus	2⅝	3½	2⅝	3⅜	3⅝	2⅝	3½	2¾	3⅞	2⅝	31⅛
Burnhouse Beauty ..	2¾	2⅝	2¾	2⅜	2¾	2¾	2⅝	2¾	2⅜	2¾	26½
Dobbie's Favourite ..	2⅞	3	2⅞	2⅝	3⅛	3	2⅞	2⅞	2⅝	2¾	28⅝
Main Crop Varieties.											
Dobbie's Prolific ..	2¼	3	3¼	2⅞	3⅛	3⅜	2⅞	3	2⅞	3	29⅝
The Provost	2⅝	2¼	2¾	2⅝	2½	2¾	2⅝	2⅝	2¼	2¾	25¾
The Factor	2⅝	2¾	2⅝	3	2⅞	2⅝	2⅝	2¾	2⅝	2¾	27¼
King Edward ..	2⅞	3	2½	3⅜	3¼	2⅜	3⅜	2¾	3¼	2¼	29
The Admiral	2⅞	2⅝	2¾	2⅝	3⅛	2⅞	2⅞	2¾	2⅝	2⅞	28
Kerr's Pink	2½	2¾	2¾	2¾	2¼	2⅝	2⅞	2¾	2½	2½	26¼
Arran Chief	3¼	2½	2½	2⅞	2¾	2½	2¾	2⅞	2⅞	2½	27⅞
Isis	2⅝	2⅛	2⅝	2½	2¼	2⅝	2½	2⅝	2¾	2½	25⅛
White City	3½	3	3⅜	3⅜	3⅛	3¼	3⅛	3⅜	3	3¼	32⅜
The Lochar	2½	2½	2½	2⅝	2½	2½	2½	2½	2½	2½	25⅛
											546⅜

Among a lot of detailed information received from the different growers reference must be limited to the following :—

The wet August adversely affected the crop of the late varieties, and so did the dry July, while the dryness of July helped the early varieties to finish off well. Mr. Sowman reports that during the growing period the plants were closely inspected. No variations in foliage of each individual variety could be detected to warrant the marking of any as rogues. Disease was more prevalent in the south than in the north. All crops were weighed as lifted. Both Mr. Veitch, of Exeter, and Professor Barker, of Bristol, speak of rust attacking "Midlothian Early" badly. While there was no rust

on any of the varieties in the lot at Edinburgh, it was rather prevalent in the field crops in Mid and East Lothian in 1917. It is most injurious to the crop, and if it occurs badly again will demand investigation. Many of the varieties gave an average of 4lb. a root, which at 3 feet × 18 inches represents a crop of 18 tons an acre.

The following table shows the total crop at each of the stations and the aggregate yield of each of the varieties at the ten stations:"—

Total crop at the different stations.		Varieties arranged in order of aggregate weight at ten stations.	
	Lb.		Lb.
Guernsey	1,340	1. British Queen.. ..	799
Edinburgh	1,337	2. Sir J. Llewellyn ..	746
Bristol	1,255	3. Dobbie's Prolific ..	668
Leeds	1,238	4. The Provost	650
Wisley	1,218	5. The Factor	643
Boston, Lincs. ..	1,199	6. Snowdrop (Resistant)	614
Co. Down (I.) ..	1,134	7. Sharpe's Express ..	606
Exeter	1,095	8. King Edward ..	601
Preston	976	9. Great Scot	593
Salop	814	10. Witch Hill	585
		11. The Admiral	576
	11,606	12. Kerr's Pink	569
		13. Secundus	567
Total weight of seed planted		14. Arran Chief	532
at the different stations	546⅜	15. Burnhouse Beauty ..	528
Ratio of increase ..	21	16. Isis	498
		17. White City	488
		18. Dobbie's Favourite ..	479
		19. The Lochar	436
		20. Midlothian Early ..	428
			11,606

Mangel Variety Trials, 1917.

In 1915 the Experiments Committee of the Agricultural Advisory Council for the Bristol Province organised a series of mangel variety trials at a number of centres in the counties constituting the Bristol Province with the object of comparing the selected varieties not only as regards crop but also as regards yield of material food value. The Agricultural Organisers of the counties concerned undertook the arrangements for the cultural side of the trials and the analytical work was carried out at Long Ashton. Since that year Worcestershire has been the only county in the Province in a position to continue the trials: in its case they have been conducted in 1916 and 1917 on similar lines to the original series.

The following report of the 1917 results has been prepared by Mr. R. C. Gaut, M.Sc., Agricultural Organiser for the county named,

and its inclusion here is due to his kindness in placing it at the disposal of the Station for publication.

"*Varieties Tested.*—The following varieties were grown :—

Variety.	Type.
1. Golden Globe (Garton)	Golden Globe
2. Golden Tankard (Sutton)	Golden Tankard
3. Red Globe (Garton)	Red Globe
4. Red Intermediate (Webb)	Red Intermediate
5. Lion Intermediate (Webb)	Yellow Intermediate
6. Prizewinner (Sutton)	Yellow Globe

County Centres.—Arrangements were made to sow four pounds of seed of each of the six varieties at the undermentioned centres in the county.

As in previous seasons the varieties were sown on uniform land and grown in the ordinary course of rotation cropping. The methods of cultivation and manuring were those practised by the farmer and may be regarded as suitable to the different soils and conditions of each locality.

The seed was sown on the ridge excepting at Centre No. 3.

1.—*Mr. D. Ballard, Home Farm, Abberley.*—Soil, a fairly deep strong loam; sub-soil clay. Previous crop, wheat following clover. Manuring for mangels per acre—farmyard manure 20 tons, fish manure 4 cwts., with nitrate of soda, 1½ cwts., and sulphate of ammonia 1½ cwts. (mixed together and applied as two top-dressings after singling). Date of sowing, 4th May. Date of sampling, 16th October.

2.—*Mr. J. H. Crane, Oakhampton, Stourport.*—Soil, a loam passing into a stronger sub-soil. Previous crop barley, which was grown with farmyard manure. Manuring for mangels per acre—night-soil a light dressing (and after ploughing ½ ton ground lime), peruvian guano 4 cwts. with nitrate of soda 1 cwt. and salt 2 cwts. (mixed together and applied as the top-dressing after singling). Date of sowing, 14th May. Date of sampling, 5th November.

3.—*Mr. F. A. Jackson, Thorn Farm, Inkberrow.*—Soil, a sandy loam passing gradually into a sandy sub-soil overlying rock. Previous crop oats following mangels. Manuring for mangels per acre—farmyard manure 15 tons, superphosphate 3 cwts., sulphate of ammonia 1 cwt., with nitrate of soda ½ cwt. (as a top-dressing after singling).

Date of sowing, 5th May. Date of sampling, 26th October.

4.—*Mr. Frank Hickton, Brookfields Farm, Belbroughton.*—Soil, a medium loam passing into a sandy sub-soil. Previous crop wheat, following clover. Manuring for mangels per acre—farmyard manure 15 tons, peruvian guano (12 p.c. ammonia, 22 p.c. phosphates, 2 p.c. potash) with nitrate of soda 1 cwt. and salt 1 cwt. (mixed together and applied as one top-dressing after singling). Date of sowing, 1st May. Date of sampling, 9th October.

5.—*Mr. R. G. Thompson, Parkmore Farm, Hartlebury.*—Soil, a medium to strong loam, sub-soil clay. Previous crop oats, (which received basic slag 5 cwts. and a " special " top-dressing), following oats, (no manure), following potatoes (farmyard manure). Manuring for mangels per acre—farmyard manure 18 tons with nitrate of soda 1 cwt. (as a top-dressing after singling). Date of sowing 27th April. Date of sampling, 29th October.

6.—*Mr. A. J. Tate, The New Farm, Rushock.*—Owing to poor and irregular germination of the seed this centre was abandoned early in the season.

Weather in Worcestershire.—Although the season of 1917 was more congenial to root crops than its predecessor, it was not an ideal mangel year. Wintry weather continued until about the 18th April and the soil was certainly very cold when sowing commenced during the last week of the month. May was marked by heavy rains and thunderstorms, particularly between the 9th and 27th. The hottest period of the year was experienced during the early part of June and this was followed by a dry spell accompanied frequently by cold nights until nearly the middle of July. Strong land got very hard on the surface and rendered singling no easy matter, especially where the mangels had been sown on the flat. The remainder of the growing season was cool and decidedly on the wet side; there was, in fact, a marked absence of the hot weather periods usually associated with July and August and sometimes with September.

Notes taken during the Growing Season.—The following is a summary of the notes taken on occasions when the centres were inspected during the growing season.

Germination of the seed was much better than in 1916 and a generally uniform plant was obtained. The failure at the Rushock centre cannot be accounted for; it was general for all the varieties.

Undoubtedly, the cold nights during early summer were not

conducive to rapid growth and the plants were a long time in filling the rows. The abundant late summer rains also kept the soil cool; consequently, there was more tendency for leaf than for root growth and there were no heavy crops nor very large roots.

Golden Globe and Golden Tankard showed a decided improvement on the previous season and at the Oakhampton centre particularly presented excellent plots.

Red Intermediate and Prizewinner were the varieties most favoured for weight at the autumn inspection, with Lion Intermediate and Red Globe following as second choice.

Weighing the Crop and Sampling.—The necessary analytical work was done at Long Ashton. Fifty cores were taken of each variety at the different centres and packed in small tins with grease-proof paper; these were despatched to Bristol without delay.

During sampling the differences in the texture of the different varieties were particularly noticeable. The roots of Golden Globe and Golden Tankard were so firm that it was difficult to extract complete cores without splitting them. Those of Lion Intermediate were, on the other hand, so "fluffy" in character that the cores often broke in the middle during extraction; numbers of the roots were also partially diseased internally—a feature noticed uniformly at all centres. Prizewinner cores also had a tendency to break inthe middle.

With respect to the texture of the other varieties there was nothing of note to report.

Arrangements have also been made for repeating the analyses in the early part of 1918. With this object in view each experimenter has promised to reserve a cart-load of roots of each variety so that the requisite number of cores may be taken.

Percentage Composition of the Roots.—The following is a statement of the Autumn analyses:—

DRY MATTER.

Variety.	Abberley.	Oakhampton.	Inkberrow.	Belbroughton.	Hartlebury.
	%	%	%	%	%
Golden Globe	12·3	13·0	12·8	12·6	13·6
Golden Tankard	13·2	12·1	12·5	11·9	13·4
Red Globe	11·7	10·4	11·4	10·3	12·2
Red Intermediate	11·07	9·6	10·3	10·1	11·6
Lion Intermediate	10·3	9·2	10·3	10·1	11·2
Prizewinner	8·3	9·1	10·1	9·9	10·2

SUGAR.

Variety.	Abberley.	Oakhampton.	Inkberrow.	Belbroughton.	Hartlebury.
Golden Globe	6·78	7·63	8·08	7·00	6·92
Golden Tankard	7·82	6·58	7·28	6·66	6·43
Red Globe	6·80	5·72	7·06	5·73	6·33
Red Intermediate	6·24	5·12	6·10	5·14	5·40
Lion Intermediate	5·97	4·38	5·80	6·38	5·56
Prizewinner	5·95	4·39	5·88	5·23	4·80

Results per Acre.—In the succeeding tables the total yield of roots per acre is given for each variety at the different centres; also the total yields per acre of dry matter and sugar as calculated from the percentages given in the preceding tables of Autumn analyses.

1.—Abberley.

Variety	Weight of Crop Tons.	Weight of Crop Cwts.	Weight of Dry Matter. Cwts.	Weight of Sugar. Cwts.
Golden Globe	29	7	72¼	39¾
Golden Tankard	32	12	86	51
Red Globe	36	19	86½	50¼
Red Intermediate	40	4	89	50¼
Lion Intermediate	39	11	81½	47¼
Prizewinner	39	11	65¾	47

2.—Oakhampton.

Variety	Weight of Crop Tons.	Weight of Crop Cwts.	Weight of Dry Matter. Cwts.	Weight of Sugar. Cwts.
Golden Globe	38	14	100½	59
Golden Tankard	40	0	96¾	52¾
Red Globe	40	15	84¾	46½
Red Intermediate	42	8	81½	43½
Lion Intermediate	44	12	82	39
Prizewinner	43	12	89¼	38¼

3.—Inkberrow.

Variety	Weight of Crop Tons.	Weight of Crop Cwts.	Weight of Dry Matter. Cwts.	Weight of Sugar. Cwts.
Golden Globe	23	10	60¼	38
Golden Tankard	29	14	74¼	43¼
Red Globe	33	7	76	47
Red Intermediate	32	13	67¼	39¾
Lion Intermediate	36	16	75¾	42¾
Prizewinner	28	1	56¼	33

4.—Belbroughton.

Variety	Weight of Crop Tons.	Weight of Crop Cwts.	Weight of Dry Matter. Cwts.	Weight of Sugar. Cwts.
Golden Globe	27	8	69	38¼
Golden Tankard	30	2	71¾	40
Red Globe	34	11	71¼	39½
Red Intermediate	33	10	67¾	34½
Lion Intermediate	30	3	61	38½
Prizewinner	31	7	62	32¾

5.—Hartlebury.

Variety	Weight of Crop Tons.	Weight of Crop Cwts.	Weight of Dry Matter. Cwts.	Weight of Sugar. Cwts.
Golden Globe	22	17	62¼	31½
Golden Tankard	23	14	63½	30½
Red Globe	25	2	61¼	31¾
Red Intermediate	26	18	62½	29
Lion Intermediate	23	13	53	26¼
Prizewinner	26	18	55	25¾

Average of the Five Centres.—The figures given below summarise the results at the different centres; they have been calculated from the five preceding tables. The average figures for the five centres in the previous season are also given for comparison.

SEASON 1917.

Variety.		Weight of crop. Tons.	Cwts.	Dry Matter. per cent.	cwts.	Sugar. per cent.	cwts.
Golden Globe	.. .. ..	28	7	12·86	72¾	7·28	41¼
Golden Tankard	.. .. ..	31	4¼	12·62	78½	6·95	43½
Red Globe ..	.. .. ..	34	3	11·20	76	6·33	43
Red Intermediate	.. ..	35	2½	10·55	73½	5·60	39¼
Lion Intermediate	.. ..	34	19	10·22	70¾	5·62	38¾
Prizewinner	.. .. ..	33	18	9·52	65¾	5·25	35¼

SEASON 1916.

Variety.		Weight of crop. Tons.	Cwts.	Dry Matter. per cent.	cwts.	Sugar. per cent.	cwts.
Golden Globe	.. .. ..	25	17	12·70	65¾	7·60	39¼
Golden Tankard	.. .. ..	24	2	12·00	58	6·80	32¾
Red Globe ..	.. .. ..	32	1	10·90	69¾	6·20	39¾
Red Intermediate	.. ..	36	8	10·20	74	5·60	40½
Lion Intermediate	.. ..	36	5	9·70	70¼	5·30	38¼
Prizewinner	.. .. ..	36	10	9·70	70¾	5·20	37¼

Results of the Trials.—The following are the chief points of interest in connection with the 1917 trials, together with notes comparing the results with those of 1916 :—

(1.)—The lower cropping powers of the varieties Golden Globe and Golden Tankard as compared with the other more robust types. The difference in weight per acre between the two groups last season was, however, not so pronounced as in 1916.

(2) The value of types like Red Globe, Red Intermediate, Lion Intermediate and Prizewinner where weight of roots is the primary consideration. The varieties have not individually preserved the same order of merit in the two years, Red Intermediate just taking precedence in 1917.

(3) The richness in percentages of dry matter and sugar of Golden Globe and Golden Tankard and the drop between these and the other varieties. The order as regards quality (with the exception of Golden Tankard at Abberley) is strikingly uniform at all the 1917 centres. The quality factor is, therefore, a well-defined variety characteristic and is only subject to variations slightly above or below the normal for the variety. The order of the varieties in the 1917 table of averages is, as in the 1916 table, the order of merit as regards quality.

(4) The excellent position, with respect to the production of dry matter and sugar per acre of Golden Globe and Golden Tankard in the 1917 table. In this connection

the Oakhampton centre stands out pre-eminently, as it has raised the average figures very considerably. When the 1916 results were compiled it seemed doubtful whether the Golden types could approximate in this respect to the more vigorous varieties, but last season's figures indicate that where these latter varieties do not yield a considerably heavier crop of roots the former may approach them or even surpass them as food producers.

(5) The differences in the physical texture of the roots of the several varieties. This character, though well known in practice, was clearly apparent while "coring" the roots for samples. Golden Globe and Golden Tankard were particularly firm, while Lion Intermediate and Prizewinner were much less solid. The physical and analytical characters of the varieties are thus closely correlated."

ADVISORY WORK.

The number of enquiries received through the post during the year was 133 as compared with 205 for the previous year. This falling-off is probably attributable to the increasing effect of the war on the ordinary county work, this view being supported by the nature of the enquiries submitted. There has been a marked reduction in the number of enquiries of the more ordinary character and an increase in those possessing special features of interest or importance under existing conditions. The following table shows the source of the enquiries :—

Gloucester (including Bristol)	24
Hereford	6
Somerset	52
Wiltshire	4
Worcester	16
Counties outside the Bristol Province	31

The latter figure includes enquiries from Devon, which county contributes an annual grant to the Institute.

Certain questions were referred to the Rothamsted Experimental Station and were dealt with by Dr. Russell, whose assistance it is desired to acknowledge.

The more interesting points raised are indicated in the following review of the general nature of the enquiries :—

Horticulture.—Few questions of special interest relating to fruit

culture came under notice. Cases of the dropping of fruits after setting, especially of nectarines and peaches, were reported. The failure of raspberries to make satisfactory growth in a plantation which had been continuously cropped with this fruit for several years has been under investigation: no specific cause was found to account for the trouble.

The preservation of fruit and vegetables by various methods has been the subject of numerous enquiries. In addition to the usual methods of bottling, pulping and drying, the use of various preservatives has engaged attention and the value of several of these substances has been examined. Problems connected with jam-making, such as the use of a variety of sugar substitutes for sweetening purposes, the failure of jams to set owing to pectin deficiencies, and the prevention of mould growth and of fermentation, were frequently dealt with.

Many questions concerning sugar beet cultivation on a small scale and methods of utilising the crop for sweetening purposes and for household jam-making were received.

Diseases of Plants and their Treatment.—The majority of enquiries under this head were concerned with potatoes. None of those in which the ordinary "late blight" was involved showed any features of special interest, but much confusion between this disease and that generally spoken of in the West of England as "potato rust" was exhibited. The latter disease was severe in certain districts both in 1916 and 1917. No specific organism has yet been discovered to be associated with it in this country. The use of home-grown seed and a dry spring and early summer appear to be two important factors favouring its prevalence. The potato spraying campaign was doubtless responsible for several applications for advice on suitable spray fluids for "potato disease," the relative merits of Bordeaux and Burgundy mixture, and the most effective formulæ for those washes. Enquiries on fungoid diseases were relatively few, but the following cases call for particular mention:—

Tomato collar rot, caused by a species of Phytophthora: seedling or young plants are most generally attacked, death quickly ensuing.

A root disease of Belladonna produced by a species of *Phytophthora*: apparently favoured by high nitrogenous manuring.

A bacterial disease of plum trees, hitherto undescribed: the bark of the trunk and main branches is attacked, death following in due course.

Disease of alder wood, due to *Fomes igniarius* and *Polyporus sulphureus:* this wood, required for clog-making, was rendered unfit for the purpose by the fungoid attacks.

The formation of "glassy" potatoes, probably associated with potato "rust" disease.

Among the enquiries relating to insect or acarine pests the following may be mentioned :—

Mites. Vine mite, *Eriophyes vites*, on the vine.
Pear leaf mite, *Eriophyes pyri*, on the apple. It is uncommon to find the apple attacked by this pest.
Epitrimerus pyri on the apple. This appears to be a new disease. The mite attacks apple leaves, producing purplish hairy spots which later become brownish. This and the preceding case occurred in the same garden.

Insects. *Swinthiurids* on potatoes.
Celery fly, *Acidea heraclei*, on celery.
Gout fly, *Chlorops taeniopus*, on
Apple leaf blister moth, *Ornix petiolella*, on the apple.
Buff tip, *Phalera bucephala*, on hazel.
Gooseberry sawfly, *Nematus ribesii*, on gooseberry.
Apple sawfly, *Hoplocampa testudinea*, on apple.
Capsids on apple.

Cider and Perry Making.—The number of enquiries on this subject has been fewer than usual. Most of the subjects have been referred to in previous Reports, but one or two special features may be noted.

Considerable interest in the preparation and use of cider vinegar has been shown owing to the increasing shortage of malt vinegar. Similarly the shortage of sugar has been responsible for enquiries as to suitable sugar substitutes for sweetening or fortifying cider.

The question of the detection of cider diluted by the addition of water has also been raised. Another enquiry concerned the protein content of cider yeast.

Agricultural Chemistry.—The subjects dealt with may be summarised as follows :—

The use of copperas as a substitute for copper sulphate in spraying mixtures.

The manurial requirements of wheat, more particularly the varying need for potash in different soils.

The manurial value of various samples of superphosphate.

The manurial requirements and the cultural methods needed in certain cases of badly cultivated land.

The manurial value of samples of horn shavings.

The potash content and manurial value of ashes of saw mill waste and of tobacco and wood ash.

In addition analyses of a number of soil samples have been made to ascertain manurial requirements.

Miscellaneous Enquiries.—Enquiries have been received on the following points :—

The preservation of broad beans and peas in salt.

The quality of a sample of radish seed.

Materials suitable for covering jars of fish paste to take the place of tin lids.

The eradication of *Crepis taraxacifolia* in meadow land.

The destruction of thistles.

The possibility of sheep dying through arsenical poisoning when turned into an orchard in August which had been sprayed with lead arsenate in spring.

Special Investigations undertaken as a result of Enquiries.—

(1) *The Treatment of Rhizoctonia disease of Asparagus.* This work has been dealt with in detail in another section of this Report.

(2) *Apple Leaf Scorch.* Further observations on this problem have been made. It was not possible, however, to continue the experiments on trees in pots which were started in 1916.

(3) *Apple Fruit Spot Disease.* Work on this subject has been continued, and considerable information as to the fungi occurring in the spots and the conditions favouring their development has been gained.

(4) *Arsenical Poisoning of Land through treatment with Tannery Leather Waste.* A case of infertility of certain land in Worcestershire following on the application of tannery leather waste as a manure was investigated, and it was found that appreciable quantities of arsenic—sufficient to have a definite toxic action on the crops grown—were

present in the soil. The source of the arsenic has been traced back to the leather waste. The question of alleviating the arsenic effect is under investigation.

(5) *The Manurial Value of Horsehair Refuse.* This material, obtained from a factory in Somerset, has been for some time utilised as a manure in the neighbourhood with apparently beneficial results, but definite information as to its manurial value was desired. The nitrogen content proved to be high, but there is some doubt as to the extent of its availability owing to the uncertainty of the rate of decomposition of the material after application to the soil. A series of experiments designed to furnish information on this point has therefore been started.

(6) *Tomato Collar Rot.* This serious disease, caused by a species of Phytophthora, has been under investigation, and efforts are being made to trace the cause of the outbreak which regularly appears in certain districts in late winter and early spring and wipes out whole batches of seedlings and of plants somewhat more advanced in growth. It is referred to more fully in another part of the Report.

Potato-spraying Work. At the request of the Food Production Department the general organisation of arrangements for potato spraying in the counties of Somerset, Wiltshire, Gloucestershire, Worcestershire and Herefordshire, was undertaken by the Station. This necessitated more or less continuous work on the subject from the middle of May to the end of July, and entailed a considerable amount of correspondence. Of the five counties Somerset and Wiltshire undertook schemes of their own to be worked by their county staffs. These appeared satisfactory and no assistance was given to them beyond general information. In Herefordshire the number of small growers (to whom the scheme applied) is very small, and arrangements were made through the Herefordshire Fruit Growers' Association that information as regards machines, material and treatment should be published as widely as possible. In Worcestershire the small growers were approached through their organised societies. Being familiar with spraying work in general they were well capable of taking the necessary steps.

In Gloucestershire, owing to the extreme demands on their time, the county staff required some assistance, and it was in their county that most time was spent.

In this county the following demonstrations in potato spraying were given :—

Gloucester ..	Two demonstrations, including a considerable country district adjoining the city.
Cirencester ..	One demonstration.
Fairford ..	One „
Longhope ..	One „

Bristol City, being outside the areas served by the county staffs, required special arrangements. Most of the allotments (total 6,000) are grouped under associations, and it was finally arranged that these associations should see to the spraying, making where necessary a reasonable charge for the work.

In addition, however, a few demonstrations were given in allotments not included under such associations, namely :—

Abbots Leigh...	One demonstration.
Knowle ..	One „
Clifton ..	One „

XIII.—ANNUAL REPORT OF THE CONSULTING CHEMIST.

(*Dr. J. A. Voelcker, M.A., F.I.C., etc.*).

Six samples, as against eight in 1916, were sent me by members of the Society, for analysis. These consisted of :—

Sulphate of Ammonia ...	1
Soil...	1
Waters	4
	6

1.—*Sulphate of Ammonia.* The sample was of good quality and analysed as follows :—

	per cent.
Nitrogen...	20.61
Equal to Ammonia ...	25.02
Moisture...	1.59

It was sold, in March, 1917, at the then regulated price of £16 per ton, delivered.

2.—*Soil.*—This came from an estate in Devonshire, and was a deep red clay loam, in pasture. It was believed that the pasture was capable of being improved.

The herbage on it, so far as I could judge, was rather thin, though individual plants of cocksfoot seemed to grow strongly. There was also an entire absence of any "matting" of roots below the surface turf, which is always a good sign, as, where such "matting" occurs, it generally means sourness of the land, and that there is merely surface growth and not penetration of the rootlets below.

Analysis of the soil yielded the following results :—

	Soil dried at 212°F.
Organic matter and loss on heating ...	12.26
Oxide of Iron	4.06
Alumina	6.15
Lime	.79
Magnesia	.92
Potash	.87
Soda	.50
Phosphoric acid	.17
Sulphuric acid	.14
Insoluble silicates and sand	74.14
	100.00
Nitrogen	.515

The soil, taking it all round, was of good, even rich, quality. There was abundant vegetable (organic) matter and nitrogen, and it was very well supplied in potash. Of phosphoric acid there was rather a small amount, perhaps, and the soil would probably be the better for more. On such a soil as this I should say that Basic Slag would be likely to answer well. Taking the figures for lime by itself, there should be plenty of this, but it will be noticed that magnesia is in excess of the lime. To this point I have drawn attention before, and regard it as an indication that land of this kind will be all the better for liming.

3.—*Waters.* The first sample sent was one of ordinary nature, the water being a perfectly good and suitable one for a drinking supply, and also by no means hard. It contained 13·44 grains per gallon of total solid matters, and had very little organic matter or ammonia.

The other three samples were sent in connection with a somewhat interesting enquiry as regards the "furring" up of iron pipes. The supply was derived from two springs, the water of each of which was analysed and found to be practically free from iron. The pipes leading from the reservoir (iron) in which the water was collected, and also

the hot water pipes in the house were, however, quite blocked up in places with a red deposit which, on examination proved to consist almost wholly of hydrated oxide of iron.

The waters were both soft, the total solid matters amounting to only 8·96 and 10·64 grains per gallon, respectively. They also contained comparatively large proportions of chlorides and nitrates, these, no doubt, accentuating the action of the soft water on the iron tanks and iron pipes.

In such cases a remedy has to be sought in the substitution of pipes coated inside with tar or with one of the compositions prepared for preventing the action of water on pipes, or else in the artificial "hardening" of the natural supply by passing it through chalk.

The Note-Book.

Our Agricultural Needs : A Suggestion.—To one who lives a little apart from the noise of the captains and the shouting, while watching with interest and amusement the labours of those who would carry captive to brand new theories and sudden experiments mankind's oldest and most honourable occupation, the fundamental aspects of farming assert themselves in all their simplicity. For some years before the war the demand for the fruits of agriculture was threatening to outstrip the supply. Not only was the price of corn rising, but so too was the birth rate, and certain nations, notably Japan, were entering the ranks of wheat eaters for the first time in their history. Statistics of this country's production tell us very little about supply and demand, for we do not raise a quarter of the corn we consume; but in the United States, for example, where the population increased from seventy-five to one hundred and one millions in sixteen years (1900–1916) meat, dairy products, cereals and potatoes all failed during that period to expand in due proportion, in spite of the double impetus given to farmers by Government action and rising prices. This meant that the possibilities of export were reduced and the prices of foodstuffs increased. It meant, too, that the quotation for grain in Winnipeg, across the border, could be ruled by the demands of St. Paul, Chicago and other great grain centres of the American West. It has been said truly enough that this war has robbed the world of millions of corn consumers; but, on the other hand, it has taken thousands of skilled corn producers and placed many miles of fertile land beyond the reach of cultivation for years to come and, though no reasonable person cares to indulge in prophecy, the prospects of the next two or three years are so grim that the partial failure of the next world wheat harvest would bring about universal shortage and two bad years might spell famine. What is needed most is the improvement of production in relation to the capital and labour employed, by means of modern machinery, modern methods, and new systems of organisation and distribution.

To give the labourer a minimum wage of 25s. weekly and to give the farmer a guaranteed price for his wheat and oats over a period of five years is to tinker—very wisely perhaps—with the main problem, but not to solve it or even to begin to solve it. We know in this country much if not all that there is to be learned about the

nature of soils, and the best crops for each kind, the relative value of manures, the worth of modern machinery, the stimulating effect of the electric current, and much else that need not be enumerated, but nothing is done to enforce upon the farmer the necessity of acquiring this modern knowledge or of farming in its light. It is his to take or leave, and, as a rule, he elects to leave it. So bad is the work of the worst of his kind that the Government has of late taken power—very hesitantly and I think without handling the financial problem effectively—to farm their land for them, and reduce it to a state of productivity. But land that has been allowed to go to waste takes years to bring into order, and it is said that while the grass is growing the horse starves. What we have to do is to see that land is not badly farmed, to take steps that will make the bad farmers impossible.

A man must serve an apprenticeship to all trades. Before he can take out a tooth or cure a headache, drive a cab, or take charge of a tramp steamer, a man must have his certificates. He may not retail a glass of beer or sell an ounce of tobacco without a licence. But he may buy a thousand acres of our good English earth and starve, rob, foul or waste it; he may hire land from a careless landlord and do the same thing with impunity as long as he pays his rent. Yet an acre of good arable land will produce 2,500 pounds of wheat, perhaps more—enough to keep a dozen men on the ration allowance for a year. Some men spoil land because they farm badly, having no expert knowledge; others because they lack the necessary capital to get the best out of their holding and in country parlance "farm for Saturday night," while there are scores of men in every country who run their farm at a profit without approaching its possibilities because they are rule-of-thumb farmers, following the traditions of their forebears and suspiciously intolerant of all change.

Every lad who, being a farmer's son or having a taste for the farmer's life, wishes to have a farm of his own should be certificated, and should prove the possession of sufficient capital or support from a land bank to handle properly the land he desires to farm. He should be obliged to attend the free course of his county farming college. In order that he may do this every county town in England should possess an agricultural college endowed by the Government, equipped with an ample experimental farm and staffed by properly paid professors. There should be a degree obtainable in farming as in the arts, science, medicine and law, and the young man who has not qualified should not be permitted to hold land. It is no answer to this suggestion to point out that many splendid farmers cannot

read or write. What might such men have achieved if education had developed their natural capacity?

In the United States, where the Government and the farmer work hand-in-hand, the National Department of Agriculture has an annual budget of seven million pounds and employs sixteen thousand trained men and women, all at the service of the agriculturist. The agricultural and associated colleges of the States have an annual income of five million pounds, and the wealth contributed annually to the State by the farmer actually exceeds the wealth added to raw material by manufacture! One does not ask for proportionate returns from Great Britain, but for something at least that makes an appreciable approach to them.

The work of the ideal agricultural college would not be limited to its farm and class-rooms. There would be extension lectures in the villages, the whole machinery of co-operation within the county would be organised from the college, and the college experts would go all over the country inspecting crops, machinery, buildings, stock, orchards, apiaries, dairies, giving advice and keeping the farmer in touch with the latest development. They would pay particular attention to the question of weeds. (In France, if a man allows his weeds to seed and infect his neighbour's clean land he is promptly punished; in England, a man may do what he pleases to the detriment of those near by and the law is powerless.) They would be in touch with land banks and with the organisation for the sale of produce, not only by the small holder, but by the cottage gardener. Naturally they would not intrude upon the farmer in his very busy season; they would go when he has the leisure to welcome them, and they would have the returns of every farm in the county before them, so that they could control bad farming and, if beyond control, put a period to it. The colleges would work under the Board of Agriculture and, subject to the limitations laid down by the Board, would have a free hand.

Until the Isle of Wight disease swept our apiaries the various county bee-keeping associations were doing similar work on a very modest scale. For a small fee, generally five shillings, the beekeeper was entitled to either one or two visits from the County Society's travelling expert. He advised, examined the hives, detected the beginnings of foul brood and other troubles, and kept a record of the work done and the state of each apiary he visited. He was always a welcome visitor, even to those of us who could keep our bees unaided. It may be urged that the farmer would resent the coming of the expert agriculturist, and this would in many cases be true for a time. But the farmer is in business to make money,

and as soon as he realised that the object of the expert was to increase his profits, and that the country in return for fixed prices and other concessions demanded high farming, he would cease to protest. He would not even object to make an annual return of crops raised, provided the return were private and not accessible to the Revenue authorities. A judicious appeal to patriotism and self-interest would work wonders and, without giving offence or establishing an inquisition, every holding in the country would come under the observation of a body of skilled men whose business it would be to see that the land was giving a fair yield.

We have some expensive agricultural colleges "for the sons of gentlemen" in England; you may read their advertisements setting out attractions that include shooting and hunting! Doubtless those who wish to justify the high fees their parents pay may learn something, but as far as the writer's information goes, and it is derived from ex-students, work is not the attractive feature of these places. The County College with its endowment would needs be a thoroughly democratic institution in which the training would be almost naval in its severity and thoroughness. Men back from the front speak in terms of admiration of the French and Belgian farming and regretfully acknowledge that we have little to match it here. With proper organisation we could rival our friends, and while it may well be that we could not for many years, if ever, become self-supporting in the matter of food, we could at least produce enough to face isolation for a prolonged period without panic.

The theory to be advanced is that the farmer, whatever his tenure, holds land not only for his own profit but in trust for his fellow-men. He must keep clean land, highly cultivated; he must farm in the light of modern knowledge; he must leave the land better than he found it, or at least no worse, and he must see to it that his holding does not disseminate evil weeds or harbour noxious vermin. To this end he must have a perfectly friendly supervisor at hand, an expert who knows and can sympathise with his difficulties without tolerating his faults. He must farm, to the limited extent suggested, in the public eye and know that what is demanded of him is his own prosperity for the public good. In any of the problems that arise in the ordinary course of his business he must understand that he can obtain the best expert advice at the price of asking for it and that the yield of every field on his farm is a matter of interest to his county and through the county to the country itself.

If farming is to take high rank as a national industry, and if the countryside is to do the best it can to replace the terrible waste of war and to supply our national services with the material that

cities can neither breed nor raise, the whole of the farming industry must be subject to a sane administrative policy. To give the farmer and the farm labourer enough to satisfy their present needs and allow the land to yield only a small proportion of its proper increase is in the long run merely to penalise the working classes, whose hard-earned wage provides the proposed subsidies. Mother Earth has to support us all; our little corner of it is able to do most of the work, provided the conditions are favourable.

Why, then, should not the whole question be viewed from a national standpoint? The cost of a week of war would more than pay for the complete machinery of change.—S.L.B. in *The New Statesman.*

The Dairy Shorthorn.—A writer in *The Breeder's Gazette* (Chicago) recently made the remark that the present world shortage of food was not a result of the War, but that the War had merely hastened its advent by some five or six years, the originating cause being the fact that the body of consumers is increasing at a faster rate than are the visible sources of supply. In no commodity is this more marked than it is in the case of beef. We may, for instance, plough up a portion of the virgin prairie in the spring and we obtain a crop of cereals in the following autumn; but in the case of beef we are dependent upon the natural birth-rate of cattle for an increase in our stocks, in addition to which the numbers of meat eaters are increasing at a faster rate than are the consumers of cereals. Even before the War some races of mankind, as, for instance, the Japanese, were beginning to eat meat for the first time, but this movement has been greatly accelerated by the War. It is no exaggeration to say that millions of soldiers belonging to the various armies of Europe, the bulk of whom were merely occasional consumers of meat, have been accustomed to a regular meat diet. The Russian Muzhik was accustomed to eat meat on two or three feast days during the course of the year, but since the War started a very large proportion of the Russian herds of cattle have been sacrificed to supply the soldiers with a regular meat diet. Messrs. R. Martens & Co., of London and Petrograd, very kindly undertook to address an inquiry on my behalf to the Russian Government as to the present position of cattle stocks in that country, and M. Pieshekhonoff, the Minister of Supplies, replied that although exact statistical data in respect to the extent of the shortage were not available, an approximate estimate placed this shortage at somewhere near 45 per cent.

Turning to the Argentine, with the exception of a few occasional

cargoes to the United States in the years 1912 and 1913, Great Britain was the only customer for Argentine meat; but now both France and Italy own fleets of refrigerator ships to deal with this traffic, and when the War is ended neither the French nor Italians are likely to desire that such an important article of food should disappear from their menus.

The increased consumption of meat has not, however, been confined to military circles. Large numbers of the working classes, both at home and abroad, have been earning unprecedented wages in munition factories, and although we may not have any accurate data to go on, their consumption of meat must have increased. Moreover, economic history teaches us that it is only rarely that the general population recedes from a new standard of comfort which it has attained, and we may therefore look for a permanent demand for beef in excess of what was required before the War. If, however, we look at the sources of supply, we see that these have decreased as a consequence of the world's upheaval. Mr. Hoover, the American Minister of Supplies, has estimated the reduction in the stocks of meat-producing animals in Europe at 113,000,000 head.

During the early spring of this year Mr. W. S. Dunn, who is well known in American live-stock circles, made a trip through the States of Montana, Washington, British Columbia, Oregon and Califorina, and then through the cotton-growing States of the south. On the conclusion of his trip he wrote me as follows: "The observations I made on the live-stock condition in this country are quite startling. Because of the high price of feed and the high price of beef and pork the farmers are cashing in a good part of their breeding stock. Dairy cows are becoming very scarce in this country."

It is obvious from the foregoing that the world will be faced with a very great shortage of beef which will have to be met. Killing off the breeding stocks may be a temporary expedient to safeguard the supply of the moment, but can only end in disaster, and it will devolve upon cattle breeders throughout the world to devise plans whereby this situation can be met.

A very large proportion of the world's beef supply has been produced in the past by single-purpose beef cattle which are kept in a semi-wild state upon the prairies and ranches in various parts of the world. It is obvious that in a country possessing any great extent of ranges beef could not be produced under a system of intensive cultivation at a price to compete with that produced on the ranges, therefore we find in all of these countries that the great bulk of the milk is produced from single-purpose dairy cattle—

Jerseys, Guernseys, Holsteins, etc. Now, however, not only has the demand for beef outstripped the supplies of range-fed beef, but owing to the increase in population and closer settlement, the numbers of range cattle are being diminished, through the ranges and prairies themselves being cut up into holdings upon which mixed farming is carried on, and which, as one writer in *The Breeder's Gazette* very tersely put it, are no place for a cow that produces a calf and then loafs for the rest of the year. The obvious way out of the impasse is to call upon the dairymen not only to supply the consumer with milk but also with beef.

Professor F. R. Marshall, U.S.A. (" Breeding of Farm Animals ") puts the matter very clearly when he says: " The western trend of population has now removed some of the economic advantages enjoyed by the ranchman in the cheapness of his land, and a return to farm-breeding is certain. The general adoption of dairy farming in older parts of the world is evidence that this kind of cattle husbandry must ultimately prevail. The eating of meat will continue so long as it can be purchased at prices within reach of the bulk of the population. Most of the Cattle must be raised in the grain-producing areas, and all the fattening must be done there. Breeders who expect to find an outlet for their surplus stock among farmers of these valuable lands must recognise the fact that the need is for a profitable beef type of animal with sufficient milking capacity in the cows to enable the owners to sell the milk from one portion of the herd, whilst the other portion raises all the calves."

Owing to the fact that our people were meat-eaters from a very early date, before the importation of foreign meat was either possible or thought of, and owing to the absence of any great extent of land suitable for cattle ranges in this country, we developed in the Shorthorn a breed of cow which is at once a good milker with an aptitude to fatten when dry, and capable of producing a bull calf which will develop into a good butcher's animal, and prove a quick and economical feeder.

Although, in response to a demand from abroad for a single-purpose beef animal to breed range cattle, a type of Shorthorn with an extreme wealth of flesh but no milk has been evolved, yet it remains a fact that the true Shorthorn is essentially a dual-purpose animal, and it is to this breed that all the world must look to solve its meat problem. Mr. Cuthbert Pope, the Secretary of the Shorthorn Society of South Africa, writes me as follows: " I know the Holland cattle well, they and the Shorthorn are, of course, originally from one source. They are attractive to those who like a black-and-white animal, and they can give any amount of milk if treated

as they would be in England But they cannot rough it a little bit. Under ordinary farmers' conditions here the milk strain Shorthorn will beat them, especially for butter production. A Friesland must have lots of good food, and then she will give lots of low average quality milk; but fatten she will not, feed her as you like—that is, in the pure state. The only thing that will save the English Dairy Shorthorn from being swamped by these cattle is the growing scarcity of beef, which you remark on. I suppose we should look at the economic side, and I may not be free from prejudice, as I am fighting the Frieslands every day of my life and gradually gaining on them. Here we have thousands of them in the pure state, and these cannot compete with the Shorthorn as a dual animal, and now that beef is beginning to come into its own here we have an advantage."

A vast quantity of milk has been spilled in the United States, in a controversy between the advocates of the single-purpose dairy cow and of the dual-purpose Shorthorn. As long as the cattle ranges were able to produce beef at a price below that at which it could be produced under an intensive system of cultivation, it was no doubt policy for the American dairymen to keep Jerseys, Guernseys, and Holsteins; but what the advocates of these breeds forget is that the governing factor in the situation is not the production of milk at the lowest possible price, but the determination of the white races of mankind to remain meat-eating peoples, and that consequently the price of beef will be kept at such a figure as will make the dual-purpose Shorthorn the most profitable cow to keep, and that when the shortage of beef reaches a certain point all the single-purpose dairy breeds will totally disappear.

When we compare the dual-purpose Shorthorn steer with his pure beef brother, we find that he is not altogether out of it. It is true that the scales are in favour of the latter, but if we examine them carefully we notice that the dual-purpose beast is principally deficient in the forequarters and that in the hindquarters the discrepancy of weight is not so marked. Now, the cheap joints which are principally used for boiling are situated in the forequarters, and the prime joints which fetch most money are situated in the middle and in the hindquarters. Moreover, the single-purpose beef animal carries a large amount of useless fat which is of little value, so that although the beef steer will attain greater weights, he will not fetch so much per cwt. as the dual-purpose Shorthorn, and consequently he may not always prove the most profitable to rear.

We may therefore, I think, anticipate a large and increasing demand for Dairy Shorthorns from the United States—not only

from the Northern States, but also from the South. Mr. W. S. Dunn, whom I have quoted above, writes: "On my way through the South I found much interest manifested among the farmers in Milking Shorthorns. The South is commencing to awaken to the fact that to save themselves they will have to stock their farms if they intend to continue farming. Many inquiries are coming from the South for bulls and females, and I predict a good business from the South for the Northern breeders."

Wealthy men are a distinct asset to the success of a breed. They are in a position to command the use of the best sires and mate them with the most outstanding females, and if they have not the requisite knowledge and skill they can command the services of those who have. I do not think that we shall be able to interest the multi-millionaire owners of America's Pet Farms in Dairy Shorthorns unless we are able to supply them with an animal able to compete with the Jersey in grace and appearance, and this is where, I think, we shall find Bates cattle of service. A recent writer in *The Breeder's Gazette* said that when Bates cattle are known in the States they will command prices even exceeding those at the Dunmore and New York Mills sales.—H. G. REGNART, M.A., in *Live Stock Journal Almanac.*

Agriculture and Sport.—Mr. M'Dougall, in a lecture to the Glasgow and West of Scotland Agricultural Discussion Society, who had a most cordial reception, said that this occasion for reviewing the whole relationship of agriculture and sport had come at an opportune moment, in view of the increasing shortage of our food supplies, and of the fact that the nation now realised what many foresaw from the beginning of the war, that the maintenance of our output of food was of most vital importance. His task that evening would be to endeavour to demonstrate the effect which the preservation of game had had, and unfortunately still had, on the production of food, and to suggest remedial measures. Touching on the progress which followed the introduction of steam power for industrial purposes, and the rapid migration of the rural population into the manufacturing centres, he pointed out that the people of this country soon accepted the conclusion that the fate of home agriculture was of no moment to the nation at large. Prior to the advent of the era of industrial prosperity referred to, the preservation of game was of no special importance to the landowner except as a means of obtaining a perfectly legitimate form of sport for himself and his friends, although poaching of course was, and continued to be, punished by severe penalties. The law, often

forgetful of the primary instincts, took no account of man's propensity to hunt for food, and made no allowance for the natural impulse which led the son of the soil to slay the creatures of the field. As the riches of the country increased, the land generally became the playground of the industrial magnates, until at length the value of an estate in land depended not so much on its agricultural or grazing worth as on the numbers of rabbits, grouse, or pheasants which were available for sport. Fur and feather took precedence over grain and mutton. With the increasing importance of sport the ranks of gamekeepers were largely augmented. In the report of the Land Enquiry Commission, it was stated that in England, between 1881 and 1901, there was an increase of 4,C00 gamekeepers, although during the same period the rural population rapidly declined. Surely this afforded food for grave thought. As the direct result of the increased numbers of gamekeepers, weasels, stoats, wild cats, owls, and other animals and birds of prey were ruthlessly slaughtered. The balance of Nature being thus upset, game of all kinds increased enormously, but more especially ground game overran the land. For generations the farmer, whose crops and grazings were destroyed by the game thus preserved had no redress whatever, and it is indeed heartrending to read and hear the intolerable conditions under which our forefathers laboured. The spirit of the age was reflected in the law of the land. It was only after the most strenuous efforts that public pressure compelled our legislature to pass the first Game Law Amendment Act of 1877. In 1880 the Ground Game Act followed. This latter statute proved of enormous benefit to the farmer in securing him against the depredations of rabbits and hares. One of the strongest arguments used by landlords against the passing of this Act, was that it would destroy the feeling of goodwill which existed between landlord and tenant. As if goodwill could possibly exist where there were crying evils to be remedied. It is curious how this old bogey is again asserting itself when the exigencies of war and the progress of the times demand a still further reform. In 1906 an amendment was made on the Act of 1880, allowing farmers on moorland and unenclosed lands an extended period for killing ground game. These Acts are, of course, limited to ground game, and do nothing to restrict the damage done by deer and winged game. Neither do they contain any provisions to safeguard the tenant against the reprehensible policy of preserving rabbits in woods, policies, home farms, and rabbit warrens—and, indeed, it is an open question whether, since the passing of the 1880 Act, this system of rabbit preservation has not increased rather

than decreased. The acreage of land wholly wasted in this way must be enormous, and the damage done to growing crops in proximity to such land is admittedly very great.

The stupendous struggle through which the nation is now passing forces us to think of all ways and means whereby the food supplies of the country can be conserved and increased. During the years of peace, when the nation had no thought of to-morrow, a strong and, from the landlord's point of view, conclusive argument in favour of the existing laws was that where damage could be proved, compensation would cover all loss. To-day such an answer is worse than none. The Act which provides that compensation may be claimed for damage done by winged or ground game has not been at all successful in attaining the object aimed at, and in any case no amount of monetary compensation can ever replace the valuable foodstuffs lost. Whoever is responsible for any preventible loss of foodstuffs is a traitor to his country. It is frequently held by practical men that game have actually increased since the passing of the Ground Game Act. For this there are several reasons, of which not least is the preservation of rabbits on policy grounds. As long as these grounds and woods are allowed to remain sanctuaries for the breeding of rabbits, farmers in their attempts to exterminate them on their lands are hopelessly handicapped. There is one such ground of over 100 acres in extent, which two summers ago grazed three horses, plus rabbits. Last summer even the horses had to retire. One field of that ground was at one time let for £70. Not only is that land waste, but it requires no effort of the imagination to understand how much the neighbouring lands suffer from the constant migration of rabbits to the cleaner surrounding pastures. All practical men know that the attempt to keep down ground game on arable or grazing ground in proximity to such policies is a hopeless task. Farmers, however, are not entirely blameless themselves. They have not taken sufficient advantage of their rights under the Ground Game Act. In too many cases they have shown hesitation in spending money for the extermination of these pests. So long as sufficient numbers are caught to make it profitable, killing is continued. Whenever the numbers are reduced below this level they cease killing, thus leaving a sufficient number to reproduce the evil. Other farmers too readily agree to the sub-letting of their rights to a shooting tenant, and for the sake of a few pounds allow their grazings to be spoilt and the quality of their stock deteriorated. The tenant whose sporting proclivities render him an inefficient farmer, must be severely dealt with.

Since the outbreak of war, evidence had been collected by the National Farmers' Union of Scotland which showed that the damage done by game of all kinds to cropping and grazing lands was still excessive. At the Scottish Chamber of Agriculture, which not only represented farming interests but also those of landowners and factors, it was unanimously admitted that a deplorable amount of damage was still being done. They, however, deprecated the idea of seeking legislation in order that the admitted evils might be remedied. It was suggested that no subject was likely to cause more friction between landlord and tenant than this question of damage by game. Was it not obviously their duty to concentrate their whole energies as agriculturists on food production, and to see to it that no false sentimental shibboleths or fears would prevent them from doing everything in their power to increase that supply? How many landowners had given their keepers strict instructions that wherever game of any kind was found damaging the food of the people it must be destroyed? To-day laws are made for the nation and not for the individual, and especially so if the interests of the individual are not compatible with those of the majority. The pride of man makes him love independence, and farmers should not be expected to ask as a concession and a privilege what the nation will justly demand as a right. On what principles do these who oppose legislation found their arguments? Surely it cannot be that they fear the patriotism of the landlord will fail under this test. Compulsion and commandeering are the order of the day. The whole world knows that no class has fought more bravely than our landed aristocracy, but to suggest that they, with their great tradition and heritage to brace them for the fight, are to be placed on a different legislative scale because they have merely done their duty is surely a gross insult to them as well as to all other classes who have so nobly given of their best. Let us remember that this is no war of classes or mercenary armies, but a war of peoples and nations fighting to the death.

The Farmers' Union proposals included provisions which operated as severely on the bad tenant as on the bad landlord. The 1880 Act provision against contracting out was not enough to prevent the landlord from attempting to evade the statute in many ways. It had been the custom, in granting leases of arable farms, to refuse permission to the tenants to winter sheep unless they bound themselves to protect the ground game. In the course of time rabbits became so numerous that the tenants, in self-preservation, employed rabbit catchers. Notice was immediately given by the landlord to stop killing the rabbits or to remove the sheep. A much more

subtle and dangerous means of evasion was adopted by some proprietors, where it was tacitly understood by all tenants that only by leaving hares and rabbits severely alone was there any possibility of getting a renewal of the lease. The rabbit must become an outcast, and, like the rat, be destroyed anywhere and anyhow.

The damage done by deer is of more recent origin. Since the latter part of last century, 1890, millions of acres have been added to the deer forest area of Scotland. Deer have now become so numerous that they have overrun large stretches of the best sheep grazings in the Highlands. What a commentary it is on our twentieth century civilisation that one-sixth of the entire area of Scotland is laid down as sporting ground, and that from Loch Awe to Cape Wrath the distance could be travelled through deer forests. Deer swoop down in their hundreds to the lower grounds, and, like a plague of locusts, devour the crops of a farm almost in a night. Does it not seem preposterous that at the present moment, when the shortage of milk is becoming acute, crops which were grown for the production of milk should be wasted in that way?

The original and even the modern deer forest areas of Scotland have now, through lack of burning and proper grazing, become so rank and wild in their growth of herbage that deer much prefer to graze on the better class sheep grazings. Deer not only destroy growing crops, but in winter and spring months, in order to keep them alive, large quantities of hay and grain are given them. The problem of exterminating deer in sufficient numbers to make any appreciable difference to agricultural interests is not a simple one.

It is unfair to blame landlords in every case for these millions of acres of Highland grazings which are now devoted to sport. In some cases there is no doubt they are responsible, but in others the conditions are wholly due to economic causes. Even this year one of the most famous sheep farms in Scotland, of 20,000 acres of sound and healthy land, could have been leased by a grazing tenant for a mere pittance. If this can be said of one of the best sheep farms, need we wonder that there are so many acres of stormier, poorer and less healthy land devoted to the monarch of the glen? The facts are that owing to unremunerative prices and other causes, these lands were not worth farming. Even in these times many of the poorer grazings yield an astonishingly small return for the capital invested. The problem of restocking these lands with sheep is a very serious one, and one that is in the majority of cases beyond the strength of either landlord or tenant. The duty must devolve on His Majesty's Government. For the immediate purposes of food-supply no great benefit may accrue, but to meet the

after-war conditions by increasing our national reserves and resources, and reducing our indebtedness for food and wool from abroad, this scheme is essential. National interests will stand to gain enormously; yet food and wool are the least of the benefits which the country will reap. The day would then be not far distant when these Highland glens would again be peopled by a hardy and virile race whose potential strength would be of incalculable value in the economic warfare of the future, which will indeed be as great a test of our resources as the Armageddon which is at present devastating Europe and menacing civilisation.

Not the least of the many misfortunes from which agriculture has suffered through game preservation was the irretrievable loss to hill grazings caused by the neglect of heather burning. Sir Hugh Shaw Stewart, in an interesting and instructive letter to the newspapers gave conclusive evidence of the advantages to be derived from heather burning. He was, however, only giving information which every sheep farmer, even fifty years ago, could have given, and which had been incessantly proffered year in and year out since then. It did not say much for the intelligence or ability of the landlord. In too many cases the damage through neglect of burning was irretrievable.

Sport of any kind is only justifiable on the grounds of health-giving exercise. All can appreciate the sportsman who walks across the moor or fields with his dogs, enjoying to the full the walk and the natural beauties, and who is content with a few brace of birds as his day's reward. Any legislation which would tend to kill this, the instinct of the real sportsman, would do an incalculable amount of harm to the manliness of our race. It is probably too much to expect that any dissertation on the conflicting interests of agriculture and sport, however impartial it may be and however much conceived in the benefit of the nation as a whole, can escape the ignorant charge of being directed against landlords as a class. Surely this is the hour—if ever—when those who are convinced of the inestimable loss which our Mother Country suffers on account of depredations by game should speak, and speak plainly, if they are to discharge their obvious duty to their country? It is more than time that we heard the last of this stupid charge. Who wants to raise such enmity? What man amongst us does not want to deal justly all round? Why should anyone who advocates the increase of home food production by the obvious method of destroying these destructive and useless creatures who use it up be accused of any enmity against the landowners? The issue of these questions may safely be left to the good sense of his fellow countrymen. Let

us drop this chatter about class enmity, and apply ourselves to the solution of the many serious problems which lie ahead of us and of our country. If we do so, we may rest assured that we shall merit the approbation of our fellow citizens, and hasten the day when our Highland glens and Lowland plains shall once again be the home of a happy, prosperous, and contented race.—*The Scottish Farmer.*

Electro-Culture of Crops.—The application of electric discharge to crop production is at the present time of more than purely technical interest. From the national aspect the introduction of an auxiliary aid to crop production by which the yield per given acre may be increased is of even greater importance than the putting of a larger acreage under cultivation. It is from this point of view, as well as from the engineering side, that the new movement for the adoption of methods of electro-culture is attracting attention. Much, however, yet remains to be done if the efforts of workers in this field are to be attended with success, and the long period of marking time terminated.

Correlation of Information.—It is a somewhat remarkable fact, considering that it is nearly two centuries since attention was first directed to the possible advantages arising from the application of electricity to plant and crop growth, and 27 years since Lemstrom revived interest in a neglected branch of electrical science, that the progress made has not been great. There seems to have been an excessive tendency for workers to shut themselves up in watertight compartments, and even to-day, although there are notable exceptions, there is in evidence a desire among many workers to refrain from any publicity regarding methods adopted or results achieved. Scientific caution and the avoidance of premature publication are commendable enough, but the experimental crops grown by electrical discharge methods during the past season in the Liverpool, Chester, Hereford, Pershore, Peckforton, Winchester, Wisley, Rothamsted, Dumfries and Cardiff districts, among others, must have yielded much valuable information concerning methods of using the current and the adaptability of the different types of apparatus to the purpose in view, which would conduce to further advance were it generally available to interested workers.

Suggested Committee.—There is room for the Imperial College of Science, through the Botanical Section of which the grant made for experimental work in electro-culture is being expended, to take steps for co-ordinating the work in hand and for uniting engineers, manufacturers, scientific workers, and agriculturists in a common effort for the solution of the problems involved. There have been,

it is understood, one or two consultations between members of the staff of the Imperial College representing the Development Commissioners and municipal authorities who are taking an interest in the extension of the application of electricity to agricultural work, including electro-culture, but it can scarcely be claimed that the necessary degree of co-operation has yet been established. Perhaps the best solution would be for the Board of Agriculture to appoint a committee on which would be represented the Incorporated Municipal Electrical Association and the Board of Agriculture, with Professor Blackman and Mr. Jorgensen, who have been charged with the conduct of research work on behalf of the Imperial College, an independent representative of farming interests, a pure physicist, and a manufacturer of electrical apparatus. If a committee of this character were appointed, and the lines of investigation settled by all the interests involved, there would be assurance that the many points on which information is desired would be attacked in a spirit which should yield results at an early date. Before the average farmer can be induced to spend money in the purchase of electrical apparatus he requires an authoritative statement as to its utility and the way in which it should be employed. A report from a committee of the character indicated, dealing with the financial as well as the technical aspects of the matter, would carry weight and serve to settle a matter which has been at issue for far too long a period.

Pioneer Work.—The first recorded work on the subject was apparently done in Great Britain, to which country the lead is, it is hoped, again reverting. It was about 1746 that one Maimbury is said to have experimented in Scotland with a frictional machine. On his work followed that of the Abbé Nollet in 1750. It was 20 years later that Jallabert, who, like Nollet, used current produced by the crude means then at the disposal of experimenters, carried out an investigation at Geneva. To him succeeded the Abbé Berthelon, whose work was done in about 1783. Between this date and the end of the 18th Century a number of investigations, in which atmospheric electricity was used, were conducted by various workers, some of whom made painstaking records of their work. One of the best known of these was Professor G. B. Beccaria, of Turin, who met with some success in his attempts to stimulate plant growth. A critical period in the history of the subject was the careful research made by the Dutch physicist Ingenhousz in 1800. He also used atmospheric electricity, but it is probable that the intensities employed were too high, and the negative results obtained, owing to the fame the experimenter held as a plant physiologist, delayed progress for a considerable period.

It was not until about 1840 that interest in the subject revived under the stimulus of encouragement offered by the Highland and Agricultural Society. William Sturgeon, who was lecturer in Natural Philosophy at the Manchester Institute of Science, described in the *Journal* of that Society a series of experiments carried out under his direction. Several areas, one in Trafford Park, another at Didsbury, and a third at Kirkby Lonsdale, were planted out for electro-culture. His results were somewhat variable. Other workers also gave attention to the subject, but it was about this period that the advantages of using artificial fertilizers began to be made known through the work of Sir John Lawes, and the obvious benefits to be thus derived quite overshadowed the problematical gains from the employment of electric discharge, and progress was again retarded.

Lemstrom and His Successors.—Nothing further of importance appears to have been done until the advent of Professor Lemstrom, who began to work at the subject in 1885. His interest in the application of electricity to crop growth arose out of impressions gained during a visit to the Arctic Circle as to the influence of atmospheric electricity on vegetation, and he experimented on a considerable scale in Finland, Germany, and England, his researches giving what has been generally accepted as proof that in some instances, under certain conditions which are still the subject of inquiry, electric discharge has a remarkable affect on the growth of vegetables, cereals, and fruit. Lemstrom's method of discharging the current through a wire network erected over the plants which were to be the subject of experiment has been followed by all subsequent workers, although naturally the design and arrangement of the wires have been modified, and other means adopted of generating the current than the influence machine used by Lemstrom.

Interest in the subject has never since abated in scientific circles, although the co-operation of agriculturists as a body has still to be secured. Experiments designed for the direct utilization of atmospheric electricity were conducted by Mr. E. H. Cook, using the discharge from the negative pole of a Wimshurst machine, about 1898, and Dr. H. G. Dorser, an American worker, who employed a Tesla alternating discharger, claims to have given demonstration of the belief generally held that the discharge acts on the aerial portion of the plant and not through the soil. Excellent work has been done during the past few years by Professor J. H. Priestley, first at Bristol and afterwards at Leeds, and by Mr. Jorgensen, who was his colleague in much of the work.

It was, however, the Lemstrom method which held the field until

Mr. J. E. Newman, who has been closely associated with the developments of the past 12 years, replaced the influence machine by the Lodge system of generating high-tension electricity. Under this system alternating current is generated by an induction coil, one terminal of the secondary being connected to earth and the other to the discharge network through a series of Lodge rectifiers. It is this apparatus, modified in detail as the result of experience, that has until now been generally employed.

Some Results Achieved.—With this source of energy and with a working pressure ranging up to 120,000 volts, charging a wire network which in the latest practice is spaced 10 yards apart at a height of 15 feet above the ground, Mr. Newman, in work at Bristol, Evesham, and Pershore, has obtained gains from wheat up to 39 per cent., with barley 5 per cent., strawberries 36 per cent., cucumbers 17 per cent., broad beans *nil*, and mangolds 25 per cent. This year the same worker has obtained on his farm at Pershore an increase of 33 per cent. in the wheat yield as compared with a control area, and a satisfactory result with mangolds. The gain in wheat is due to a better filling of the ears and heavier grain. He intends to lay down plant to supply electric discharge to 100 acres next season and as he is an electrical engineer as well as an agriculturist his work will be followed with much interest. At Lincluden, near Dumfries, where Miss Dudgeon has been growing experimental crops for some years past, the report on last season's working, which has been made by Professor V. H. Blackman and Mr. Jorgensen, refers to an increased yield from oats of 49 per cent. in grain and 88 per cent. in straw, thus confirming the experience of earlier years. These are the chief definite results available of recent experiments. At Liverpool the crop selected for the past season's tests were garden produce and oats and the experiments, which were conducted by the corporation and their electrical department, are said to have given proof of the beneficial effects of the electrical discharge.

At Hereford, under the direction of Mr. W. T. Kerr, 60 acres are to be planted for test purposes, and at Chester three separate areas of 1½ acres, 10 acres, and 14 acres have been allocated by the electrical engineer of the city, Mr S. E. Britton, for experimental work, with various types of apparatus.

Problems to be Solved.—The projected additions to areas under cultivation, together with the proposed tests of the various types of generators and equipment, should lead to the accumulation of data which will throw light on the primary questions to be solved. These refer to the manner in which the electric discharge acts on

growing crops, which is a subject for the plant physiologists from whom a committee to deal with the matter has just been formed; to the best method of utilising the electric current; and to the kinds of crop to which the services of this adjunct can be applied with the greatest advantage. Much depends on the replies to these questions. Even when satisfactory answers have been obtained, there is much to be done by electric supply authorities. There can be no marked extension of the use of electricity in agriculture, whether for stimulating plant growth or other purposes, until electric supply authorities have carried their mains into all important farming areas. This question is at the present time receiving the close attention of a committee of the Incorporated Municipal Electrical Association.—*The Times* (*Engineering Supplement*).

Selecting a Good Milk Cow.—It is a difficult task to select a milk cow from appearance alone. Even the best judges of dairy cattle cannot tell whether a cow will produce 250 pounds of butter-fat in one year, or 350.

In view of the difficulty in picking out a good cow from appearance alone, it is a good plan to select one, if possible, from a herd where the ancestry of the animals is known. In the average herd there is nearly always some outstanding cow or cows that will produce several times as much milk and butter fat as other cows in the same herd. In purchasing a cow that is known to be a producer, or a heifer from a cow of this type, one is more certain to get a good producer than if he selects a cow at random without knowing anything of her ancestry.

There is no doubt that there is a certain type of form that is associated with large milk production, and in conformation the dairy cow is quite the opposite of the beef animal. The dairy cow is angular, spare in flesh, and is usually referred to as being wedge-shaped, while the beef animal has a square, blocky form. The score card given at the end of this article may be used as a guide in selecting cows. It shows the relative importance of the different points of the body. The beginner should study this carefully so as to become thoroughly familiar with all the points of a dairy cow.

The first impression one gets when viewing a high-producing cow, or a photo of a high producer, is the marked angularity and thin loose-jointed appearance. The thin appearance is not a condition caused by lack of feed, but the animal is well-muscled and neat, with the hair and skin in good healthy condition. The angular conformation is best described by the term "wedge-shaped." The dairy cow has three wedges. A wedge is noticed when the cow is

viewed from the front, from the side, and also from above. The first wedge mentioned is formed by the withers being sharp at the top and the chest being wide at the base. The depth through the rear part of the barrel and udder tapering to the neck and head forms the wedge as viewed from the side. The wedge, as seen from above, is formed by the extreme width through the hips gradually tapering to the sharp withers. The wedge shape is not extremely pronounced in all dairy cows, but is usually found in the best animals.

Indications of Quality.—The dairy cow should have plenty of quality. High production of milk and butter fat is associated with this characteristic. Quality is indicated by fine hair, soft, loose, mellow skin of medium thickness, and a fine, clean bone. Dairy temperament is another essential. By this is meant the ability to convert the feed into milk and it is indicated by a good nervous system well under control. A cow may have a good nervous system yet not have the dairy temperament, on account of the nervous system not being under control. A good nervous system is indicated by a neat, refined appearance, spareness in flesh when in milk, and a large, full, mild eye. The dairy cow should be healthy and in good condition; should be spare in flesh while in milk, but may be allowed to carry considerable flesh when not giving milk.

Important Points of Head.—The head should be clean cut, of medium length, and of feminine appearance. The eye should be large, bright, and full. A mild expression in the eyes indicates a good disposition. The forehead should be slightly dished and broad. The jaw should be strong and wide, tapering somewhat to a strong broad muzzle. A good-sized muzzle and strong jaw are indications of a good feeder. The ears should be of medium length, good texture and fine quality, with an abundance of orange or yellow colour inside. This colour is believed to indicate the richness of the milk. The neck of the cow should be moderately long, thin and muscular, with clean throat and light dewlap. The neck of the typical dairy cow does not join the body as neatly as does the neck of the beef animal, but is long, lean, and free from fleshiness.

Body should show Capacity.—The heart girth should be large, indicating lung and heart capacity. The back should be long, strong, and loose-jointed, but not necessarily straight. The ribs should be long, wide, and deep, especially just in front of the udder. A cow must have capacity of barrel to be able to handle large amounts of food. Often a cow will not show a great depth of barrel but may have a greater capacity for food by having a greater width of barrel

and wide spring of ribs. A strong jaw, keen eye, large muzzle and capacious barrel are the indications of ability to consume and digest large quantities of food, which is necessary for high production. The loin should be broad and strong, with roomy coupling.

Hindquarters Lean and Angular.—The hindquarters should show the leanness characteristic of other parts of the body. The hips should be far apart, prominent, and level with the back. The rump should be long and wide, with a roomy pelvis; the pin bones high and wide apart. Such a conformation of this region affords plenty of room for the generative organs and reproduction. The thighs should be long, thin, and wide apart, with plenty of room for the udder. The legs should be fine, straight, and far apart.

Udder of Great Importance.—The udder of the cow is one of the most essential organs, and is largely used as a determining factor of the ability of the cow as a producer. The udder should be capacious, free from flesh, and when empty should be soft and flexible. Capacity of the udder should be gained by length and width rather than depth. It should be attached to the body high behind and far forward toward the navel and show plenty of width throughout. This conformation permits of more surface for the blood vessels to spread over as they pass through the udder. The udder is the milk factory, where the nutrients are taken from the blood and made into milk.

By some unknown process in the udder the food materials taken from the blood are changed to the substances found in the milk. The milk veins serve as an index to the amount of blood that flows through the udder. These veins carry the blood from the udder back to the heart. They can be noticed leading from the forequarters of the udder and running forward just underneath the skin and entering the abdomen near the centre of the body. The milk wells, through which the milk veins enter the body, should be large. There may be more than one milk well on each side of the body. In some cases the milk veins branch as they leave the udder and enter the body in several places. Cows have been known to have as many as five milk wells on each side, and it is not uncommon to find cows with two or three milk wells on each side of the body.

The quarters of the udder should be even in size and not cut up; but the base or sole of the udder should be flat. The teats should be even, of good size for milking conveniently, and set squarely on each quarter of the udder. The hair on the udder should be fine and soft, indicating quality.

The brief description given of what to look for in a good dairy cow is based on the experience the writer has gained in studying

dairy cows in a good many high-producing herds. One who follows these suggestions can be reasonably sure of selecting a cow that is above the average in dairy production.—

SCALE OF POINTS FOR DAIRY CATTLE.

	Possible Score.
General Appearance, 18:	
1. Form—Inclined to be wedge-shaped	6
2. Quality—Hair fine, soft; skin mellow, loose, medium thickness; bone clean, fine	6
3. Temperament—Nervous, indicated by lean appearance when in milk	6
Head and Neck, 7:	
4. Muzzle—Clean cut; mouth large; nostrils large	1
5. Eyes—Large, bright, full, mild	1
6. Face—Lean, long; quiet expression	1
7. Forehead—broad	1
8. Ears—medium size, yellow inside, fine texture	1
9. Horns—Fine texture, waxy	1
10. Neck—Fine, medium length; throat clean; light dewlap	1
Fore Quarters, 5:	
11. Withers—Lean, thin	1
12. Shoulders—Light, oblique	2
13. Legs—straight, short; shank fine	2
Body, 26:	
14. Chest—Deep, low; girth large, with full fore flank	10
15. Barrel—Ribs broad, long, wide apart; large stomach	10
16. Back—Lean, straight, open-jointed	2
17. Loin—Broad	2
18. Navel—Large	2
Hind Quarters, 44:	
19. Hips—Far apart, level	2
20. Rump—Long, wide	2
21. Pin Bones or Thurls—High, wide apart	1
22. Tail—Long, slim; fine hair in switch	1
23. Thighs—Thin, long	4
24. Udder—Long, attached high and full behind, extending far in front and full, flexible; quarters even and free from fleshiness	22
25. Teats—Large, evenly placed	5
26. Mammary Veins—Large, long, tortuous, branched, with double extensions; large and numerous milk wells	5
27. Legs—Straight; shank fine	2
Total	100

—*Modern Farming.*

Ram Breeding.—Ram breeding is the highest branch of sheep raising, and even when carried on under the best conditions it is a business which exacts the exercise of sound judgment on the part of the breeder. There is of necessity a vast difference between the management of a high-class ram breeding flock and of one which is maintained solely on commercial lines, for different aims and methods have to be followed to achieve success. At the same time the principles of breeding as pursued by great cattle breeders are equally applicable to sheep breeding, and the influences of both male and female elements must receive the same consideration.

A ram breeder must not only be a first-rate judge, but he must thoroughly understand the principles which govern the art of breeding, and must also thoroughly know how to manage a flock of sheep. Needless to say, command of capital is essential, for there is always a " waiting " period in front of one who takes up ram breeding, and it is often several years before a flock attains such distinction as to create a keen demand for rams and ewes for both home and foreign customers. First of all he must produce the right stock, bring them before the public at shows and sales, and advertise his flock well, and in due time, with the exercise of good judgment and careful management, and with the assistance of a good shepherd, he will find success. Soil and situation play a very important part in ram breeding. The business should on no account be taken up on unsuitable soils.

The establishment of a high-class flock takes considerable time and money. An established flock may be bought in its entirety., but although this may save a few years, it is certain to cost much, especially in these days. Otherwise ewes must be got together from the best flocks available. These will be drafted into the flock, and, provided they have been selected as near to type as possible, this will probably be found the easiest way of making a beginning.

Grading up a flock is a slow and tedious business, and, as in building up a herd of cattle, it takes a lifetime to raise it to a high degree of merit. It is useless to attempt to breed high-class rams from just ordinary ewes, any more than to attempt to breed a high-class bull from any ordinary cow. Like bull breeding, ram breeding is a thing apart, and we must look to the purest and best blood to produce high-class and reliable sires.

As in all other branches of stock breeding, it is always cheapest to begin with the best, and he who wishes to become famous in the sheep world must start with the best of ewes and mate them with the pick of available sires. Shearling ewes are always the most

satisfactory to purchase by way of a start. Draft ewes from high-class flocks sometimes go cheaply enough, but they are always irregular in appearance. Their best days are over, and although they may breed one crop of lambs, yet there is the certainty that had they been of any further use to their late owner he would not have parted with them. Shearling ewes are more regular in appearance, can usually be obtained truer to type, and they have their lives before them; it is an excellent plan to purchase also a few pens of ewe lambs as a follow on. No breeder can keep all his shearling ewes, and therefore after he has had first pick he has usually a good number to dispose of, whereas in most ram breeding flocks all the best breeding ewes are kept as long as they are useful, and the value of such breeding ewes is incalculable, inasmuch as they produce lambs which realise in the aggregate hundreds of pounds. There are ewes in all ram breeding flocks which never breed a bad offspring and for years in succession produce prize-winning animals.

Great sires have made some flocks famous, and should be kept as long as they are serviceable. The custom of using ram lambs, which prevails extensively in South Country flocks, means trusting to their merits and their breeding, but it is seldom that a man goes wrong when he purchases his sires from flocks of established reputation.

At the same time, with a ram, just as with any other stud animal, no one can tell his capabilities as a sire until he has seen the produce, and when that is satisfactory it is advisable to keep him as long as he is serviceable.

It is the young and untried sires which always fetch the most money, and a two or three shear ram can often be picked up very cheaply at a sale, for at most home sales there is an opportunity of inspecting the stock, and, provided that is good, a well-tried sire is always worth securing.

The management of a ram breeding flock is very different to that of a commercial one, the lambs from which are annually fed off on turnips and marketed as fat lamb, all the males being castrated. The ram breeder must keep the sexes divided, and all kinds of crops have to be grown for the benefit of the ram lambs. Everything possible must be done to promote growth and to maintain health and vigour in the young rams, and they must from weaning time onwards be given many varieties of succulent foods, to come in rotation, in order to provide both variety of feed and fresh soil from time to time. There are, of course, various systems of management in different parts of the country, but they all tend to the same object, viz., the promotion of health and vigorous growth. The

success or failure of a ram breeding flock depends very much on the shepherd, and no pains should be spared in securing a first-class man. He should always be consulted in all matters appertaining to the breeding and management of the flock.—*Live Stock Journal.*

Silos for British Dairying.—There can be no doubt that one of the things which must enter into the science of British farming is the process described as ensilage. Up to the present it is comparatively unknown in this country, and is only being practised by a little band of agriculturists, whose restless enterprise keeps them abreast of the times.

Yet it is a system that no farmer, did he only know it, can afford to ignore. For one thing it is money-making, and for another it saves the farmer a world of worry in the dead season, when feed is scarce and dear.

It is not necessary for us to dwell on the stupendous effect of an ever-abundant supply of wholesome green fodder throughout the winter—and every winter. Yet this is what a silo will do, and does do for those few farmers in England who have been quick to adopt its use.

We regard the silo as being of the utmost material importance. From every point of view it offers the most valuable help. At the present moment, when British dairy farming has a critical period in front of it, through a probable shortage of feeding stuffs and the high prices of the supply which is available, the silo would have saved the situation, saved the farmer, and saved the people.

So that the British farmer may know what is being done with ensilage in his own country, a representative of *Modern Farming* has had a special interview with the pioneer of the movement, and we shall be greatly mistaken if the glowing success of the silo in Norfolk does not awaken a lively interest amongst English agriculturists in this sure and certain method of providing against a bad season.

That the system of ensilage farming in Norfolk is now steadily triumphing over the prejudice and inertia by which it was long beset is due primarily to the influence of example. Experience, abreast of the best American methods, has evolved an almost perfect method of fodder conservation, as anybody can see for himself who will go to the trouble of paying a visit here and there, and digesting the carefully worked out statistical comparisons of the subject.

In Norfolk, the pioneer of the system is Mr. George Jaques, of Tivetshall, who has been farming there for about five years. Previously he spent eleven years in Canada. From there and also from

his travels in the United States he has brought home a contagious enthusiasm for new ideas, and a corresponding dislike of that rooted obstinacy which flourishes still, in spite of patent demonstrations pointing to the advantage of newer systems.

"Fernleigh," at Tivetshall, is an experimental silage farm. Mr. Jaques has there made tests and records which have led him to the confident conclusion that to leave roots out of the customary rotation, and to substitute leguminous fodder crops to be converted afterwards into silage, is to economise in feeding stuffs, labour, and artificial manures. He makes no selfish secret of this experience. The points of his contention are mainly that roots are subject to the variations of season, and therefore of crop, whereas the yield of an autumn-sown leguminous fodder crop does not vary, and that while one acre of pasture will provide the feed of one cow for six months, three cows may on the silage method be fed for that time from the same area.

The silo which he prefers is the creosoted wood stave Norfolk silo, as made by Messrs. Jewson & Sons, of Norwich. This building is cylindrical in shape, and stands on a concrete base. The staves of the silo are tongued and grooved, with bevelled edges, thus forming a circular wood wall practically impervious to air. It is provided with a continuous doorway, fitted with removeable and interchangeable doors. In filling the silo, the green crop is cut up into about half-inch lengths by means of a rotary cutting machine. The machine is provided with a revolving fan for blowing the fodder through a pipe into the silo.

Mr. Jaques was the first farmer in England to erect a silo of creosoted wooden staves, but he does not claim that it was any invention of his. It is the outcome of the best experience of America, where there are now some 750,000 silos in use, and the old clamp silo is everywhere superseded. His own farming experience in England had strongly impressed on him the importance of a preservative system by which June feed conditions may be procured in January. In 1911 the root crop failed. In 1914 it failed again, and in the spring of 1917 it was badly damaged by the frost.

Since 1911 there have been bumping crops, yielding 14 tons of silage per acre, equal in feeding value to 37½ tons of roots, and they have been grown at a great deal less expense. In America the summer silo is coming into use. In the Central States, where land is worth from £30 to £50 an acre, it does not pay to keep land laid down to grass. How can it be worth while here to lay down to grass land which would be worth a good deal more if otherwise treated?

Because of their labour troubles the American people seem to be

more accessible to new ideas. Cheap and abundant labour has been the curse of the English farmer. He has had no incentive to reach out after new ideas, and yet what a chance he has! His climatic conditions are unrivalled. The world's market is at his back door. He has no overseas transportations to burden him. He does not know the meaning of trusts, and the labour which he can command is the most efficient in the world. You cannot beat England in point of all the best agricultural advantages. The average yield, high as it is, could be made much higher if we could counteract that indifferent quality in the farming which the war agricultural conditions have been showing up.

The silage crop comes off at the end of June or the beginning of July, and the land can then be cultivated. Basic slag or some other phosphatic manure can be put on, and the land will then be ready for wheat. Mr. Jaques does not believe there is any sound objection to the change involved in the four-course shift.

In regard to labour, which is by far the most important factor in the farmer's affairs, his experience is that there is a great saving if the silo is in a proper position.

One can save at least four or five pounds of cake a day if silage is used as the feeding basis instead of roots. He fed his pedigree Suffolk mares last winter on 15lb. of silage a day, in addition to some very poor hay, and 3/5lb. of soaked maize.

As regards the argument that in the making of silage there are questions other than cost of production to be considered, such, for example, as cleaning the land, fallowing, and manuring, he thinks land can best be cleaned when there is a hot sun in the middle of the summer, and more cheaply with horses than hand hoes, while nitrogen is fixed in the land by the legumes, so that it need not be bought.

Mr. Jaques says the Americans consider that a silo pays for itself in one year. This agrees with his own experience, and is confirmed by others who have adopted Norfolk silos. A creosoted stave Norfolk silo, if care be taken to adjust the lugs on the hoops so as to control its necessary liability to contraction and expansion, ought to last sixty years.—*Modern Farming.*

Grading up Commercial Cattle.—Mr. Prothero, Minister of Agriculture, speaking at Darlington, on 5th October, 1917, said: "A hundred and fifty years ago winter feeding was unknown. Cattle, fattened on summer grass, were slaughtered in the autumn, and people lived in the winter on dried and salted beef."

A hundred and fifty years ago the cattle of this country were not

adapted for winter feeding; they were a big-boned, heavy, slow-maturing race. They never got fat as we understand the term; they slowly gathered flesh, and by the time they were five, six, or seven years old they were judged fit for slaughter. There were no weekly markets in these good old days. The art of feeding was then unknown. As an art it has been of slow growth, and a century and a half has been needed to develop it. For when the pioneers of feeding had their first dim perceptions of what might be done they had not the wherewithal to do it. They had neither roots nor concentrated foods, and prejudices and policy were strongly opposed to feeding grain to cattle. Nor were the cattle adapted for even reasonably early maturity. With a change in feeding had to come a change in cattle, and both came slowly.

We are not in reality so very far from these benighted days. Only a few generations separate us from them. The progress made has been slow, steady, and continuous. Think what it means. Apart from grass, it involved an entire change in the food of a race of animals. This food had to be grown or imported. Growing it entailed a revolution in cropping. It also meant a complete change in the character of the cattle of the country—not a mere grading up, but a transformation. These changes might have come about faster; but then, as now, there were men who did things because their grandfathers did them! With the difficulties already noted this explains why the breeding and feeding of cattle are not further advanced to-day.

The first move was to originate a race of cattle that laid on fat as well as flesh, or, to put it better, fat in conjunction with flesh. We laugh at these old-time cattle, at the "sixteen inches of fat on the ribs." The then most famous cow would be taken to-day as an example of what to avoid in breeding, but in those days was a marvel! Nor must we mock at these monstrosities. The greatest need of that time was a fat-producing animal, and these early specimens gave it, abundantly, unstintedly. There was little to admire in the unsightly rolls of fat, but when these cattle were crossed with the common herds of the country they brought about a marvellous improvement in their flesh, and produced what was so greatly needed, a carcase of intermingled fat and lean.

It would be easy to give many examples of what was done in stock improvement in these days. But only a few farmers were really stock improvers, and levelling up the stock of the country was a slow process.

The provision of suitable food was also a great difficulty. Farmers could not grow root crops by intuition. They had to learn the

method, and by repeated failures feel their way to success. To-day the root crop is greatly dependent on artificial manures, and there were practically no artificial manures in these early days. Of concentrated foods there was an equally complete absence. Sound grain, at a time when Corn Laws were in force, was all needed to feed the population of the country, and only damaged grain and screenings could be spared for stock. Importations of cakes and other feeding stuffs are of comparatively recent growth, and it is only lately they have assumed colossal proportions. These and other causes delayed any general improvement in live stock.

A saunter through any cattle fair will show that though much has been accomplished, much yet remains to be done. A further improvement in stock and greater attention to feeding could enormously increase our output of beef. There are still far too many men who dare not break away from old traditions, far too many who will use any sort of bull in their herds if it has but horns and a tail. There are still great numbers whose ideas of feeding are altogether behind the times, and who fail to keep their cattle steadily growing—who allow them to get into low, unthrifty condition from which it takes months to stir them. There are examples before them on a large scale and on a small scale, yet they fail to grasp their importance.

Ireland furnishes an example on a large scale. A generation ago the store cattle they sent to this country were nondescripts; small of size, thin in flesh, slow feeders, scraggy, inferior beasts. To-day they are amongst the best grazers in the country, mostly grade Shorthorns, thick-fleshed, early maturing, and producing the best quality of beef. The Irish farmer has not been noted for his pioneering, but by means of high-class sires, subsidized by the Irish Board of Agriculture, he has most materially levelled up the general excellence of his herds. He has done it because he found it paid him, just as it would pay any breeder who did likewise. We have a similar live-stock improvement scheme for England, but it is of small proportions.

Another illustration of stock improvement on a large scale is in the production of the blue-greys of Cumberland. No store stock in the country bring as high prices. It is the result of careful breeding. White Shorthorn bulls of high quality are mated with Galloway cows, and the results are blue-grey calves, uniform in colour, and of a regular high quality. Suitably reared, they grow into the best store cattle procurable in the country.

For examples on a small scale we must look to the enlightened breeders to be found in almost every parish, whose example might

be worthily followed. Their name and fame may not extend beyond the confines of their own market town, but they are well and truly doing their duty and showing an example to their fellow farmers.

There is a prejudice against the use of pedigree bulls that should be named, for it is responsible for some of the indifference shown towards them. They are said to ruin the milking qualities of the herds they are used in. There are, no doubt, some grounds for this view, and it must not be ignored. But to a great extent it can be obviated by the careful selection of a sire. There are good milking strains amongst pedigree cattle, and if drawn on they will give excellent results both in flesh and milk. There are breeders who lay themselves out to produce sires of this dual-purpose class, and the Shorthorns of the north-west of England, largely bred in Cumberland and Westmoreland, and sold at the Penrith sales, are, generally speaking, of this character.

The outstanding fact for us to face to-day is that the general standard of the cattle of this country is not so high as it should be. How can we alter it? By a careful study of the past, which will reveal to us how progress has already been made and maintained, and how we can now apply the same processes. There is no royal road to improvement. It can be done only by an infinite capacity for taking pains. The man who can comprehend the work of bygone days, grasp the underlying principles of past improvements, and who can set himself to emulate his progressive neighbours, will solve the difficulty. He must not only breed good stock, but he must get his land into such a high state of cultivation that it will produce for him an abundance of cattle food. He must also know what to buy, when the War is over, in the shape of concentrated foods, so as to get a good return for his outlay.

Individual effort will do the greater part of the improvement, as it always has done, but all help possible must be rendered. The Government's Live Stock Improvement Scheme has been referred to. In some parts of the country it can be extended with profit. There is an admirable series of Notes on Feeding Stuffs from the Animal Nutrition Institute of Cambridge University, published monthly in the Journal of the Board of Agriculture. This will help in the selection and use of feeding stuffs. There must also be as much publicity as possible given to breeding and feeding experiments that have given good results or that teach practical lessons. Improved cultivation, a greater choice of forage plants, additions to our list of imported concentrated foods, such as soya bean and the earth nut, are all aids to stock improvement that cannot be overlooked.

Neither must general agricultural education be forgotten. "The part of a farmer's holding that pays best for cultivation is that which is bounded by the ring-fence of his own skull."

The individual farmer is the bed rock of progress. If he rouses himself, or can be roused, to the possibilities of the situation, the greatest and most important step towards the grading up of the commercial cattle of the country has been taken. These are the times to stir, but unless he is willing to take action example and exhortation are in vain.—WM. PARLOUR in *Live Stock Journal Almanack.*

Grass and Live Stock.—Heartily as we approve of the conversion of a considerable area of our permanent pastures into arable land yet, if grass land is broken up, some substitutes for the food of live stock must be provided, or our flocks and herds are bound to suffer. Fortunately, a reduction in the area under permanent pasture does not necessarily mean any reduction in our capacity to maintain a large head of live stock, but it means that steps must be taken in proper time to provide the necessary food. It would be nothing less than a national catastrophe if any carelessness or want of foresight caused even a temporary incapacity to maintain our live stock at its present numbers. Europe, and indeed the whole world, is being depleted of its cattle, sheep, and pigs, so it is the more important that our own stocks should be maintained at a high level. These stocks may yet be required as food; they will certainly be wanted for breeding purposes all over the world as soon as the war is over.

As time goes on, and experience is accumulated, we are certain to find many new ways of providing food for live stock from arable land, but it is worth remembering now that those who are ploughing up grass this season will have to make some provision for their stock, or keep fewer during the coming autumn and winter, while those contemplating the breaking up of grass ready for cropping next season will also require to make plans for the feeding of their live stock during the following year. Certainly no one should think for a moment of keeping a reduced head of stock. It would be the greatest possible mistake from a personal as well as a national point of view, and we would strongly advise everyone not only to lay his plans for keeping as many cattle, sheep and pigs as heretofore, but to contemplate the possibility of keeping more in the near future. A little sulphate of ammonia on a field to be mown for hay, a little extra manure and labour on the root crop, an acre or two of tares sown at the end of April, or a few thousand cabbage plants put out by the beginning of June may provide all that is required. In any case it will be a provision against a dry autumn.

It is, however, for rather further ahead we are thinking. A considerably larger area of permanent grass will undoubtedly be ploughed up, and it is this that may mean a serious curtailment of the area available for the grazing of live stock, and must be provided for in good time. We would especially commend to the attention of farmers the provision of temporary pastures and of leys for mowing for hay. Far larger crops of hay can be cut off manured leys than can be obtained from permanent pastures, while if suitable mixtures are sown they can be left down for grazing during the second year. It is surprising how much can be done in this way, and the amount of keep that can be got off a comparatively small area by manuring. A temporary pasture, due to be ploughed up in the course of a year or two, can be treated in quite a different way to a permanent pasture. It can be used largely as a place on which to feed crops grown on other parts of the farm. For example, tares and mixtures of tares and oats, cabbage, and other green fodders can be fed on these temporary pastures all the summer, and the manuring they get in this way puts them in excellent condition for the corn crop that follows.

If such leys are to be provided they must be sown in spring. It must also be settled whether they are to be one-year leys for mowing only, or if they are to be left down for a second year, as then a different mixture of seeds must be sown. It may be said, of course, that it will be useless ploughing up permanent pastures to increase the arable area of the country if temporary pastures are to be immediately sown down. This is not so, however, for these temporary pastures need not occupy so large an area as the permanent grass ploughed up, they will grow a much greater weight of green food or hay per acre, and the more cattle they graze and the more they are manured the better the corn crops will be for the rest of the rotation. It is highly probable, on mixed farms on which the arable land is run on the four-course rotation, that by treating the seeds well a much greater amount of stock keep will be obtained from the seeds without extending the area beyond that which will come from the extension of the arable land by the ploughing of the permanent grass. The area of seeds will be extended as the rotation progresses by one-quarter of the area of the grass ploughed up, the remaining three-quarters carrying other crops.

A great deal will be learnt about the keeping of stock on a smaller area of grass as experience is gained. The feeding of dairy cows and other live stock on the produce of arable land has become a fine art in Denmark, and there are a few instances in which it is well done in this country. It requires a little more labour than grazing, but it

is found to pay well owing to the larger number of stock that can be kept on a given area and the extra manure produced. Much will be done, too, in the making of silage for the winter feeding of cattle and sheep, and, as experience in its use is gained, it will be found that by feeding silage produced from leguminous crops grown on the arable land a considerable reduction will be possible in the expenditure upon cakes and other feeding stuffs.

The experience of men like Mr. Falconer, whose paper before the Farmers' Club deserves attention, shows that there is little fear of loss from wireworm or other causes if the grass is broken up at the right time of year, and that the land can soon be brought into the ordinary rotation of the farm. The manuring of the remaining grassland is certain to increase its stock-carrying capacity, so that, with this improvement and the provision of some further keep from the arable land, stock-keepers need not anticipate any need for the reduction of their herds. It is most desirable that the numbers should be kept up.—*Agricultural Gazette.*

Digestive Troubles in the Horse.—These troubles comprise the most important, from the economic point of view, of all that affect the agricultural interest. They include everything that prevents or interferes with the assimilation of food—sore lips, or bad teeth, or any obstruction in the passage downwards of the food, and any inability to deal with it after it has arrived in the stomach, or left it for the completion of the processes of digestion, of which seven are recognised by physiologists. Having regard, then, to the numerous and complicated processes by which vegetable substances are converted to the purposes of heat, energy and growth, as well as to development in the direction we desire, it is not surprising that digestive difficulties are often met with in animals which are domesticated, due to this rather than to their primary habits and desires. Such a large subject can be only briefly dealt with in the space at our disposal, but it is possible to point to some of the common causes of these ailments, and make suggestions to the less experienced among our readers which may be worth perusal.

Paralysed lips prevent the easy grasping of food, which is the natural way of the equine species, as the tongue and dental pad are used by ruminants. Heavy and hard bridles and head collars and severe bits give rise to this trouble, and the pendulous lip is an eyesore which depreciates the value of an animal, though he may have learned to seize his food with the teeth, and plunge his muzzle into a sloppy mash and suck it up like a pig. It should, therefore, be one of the functions of the master's eye to see that harness gear

is always suited to his horses, neither weighted with heavy bosses and ornaments by the proud carter, nor stiff and hard as the result of neglect by the indifferent one. There is very little in the way of treatment that is likely to benefit a horse with a pendulous lip, but we have seen recovery when the cause could be traced and removed, and as a result of blistering along the course of the nerve.

Stomatitis, or breaking out upon the lips, is another hindrance to eating. It is due to an infectious organism, and more often occurs as an eruption inside the mouth. The membranes of the cheek and tongue are covered with vesicles which rapidly mature and break, leaving a scalded or abraded area, from the irritation of which an abundant flow of saliva is maintained for a few days. The slavering suggests foot-and-mouth disease, and the sloughing of patches of membrane from the mouth and tongue make the parts very sore for the time, but the animal seldom goes off his feed. He may leave straw chaff and other hard and prickly stuff, but this is not due to want of appetite, or to the slight elevation of temperature which accompanies the malady. The pimples on the lips and muzzle are generally of a simple nature, but in a few cases they prove rather intractable, by reason of the subject rubbing them on the manger, and food particles then adhere to the small sores he has caused. On account of its infectiousness the patient should be separated from the stud, and to facilitate recovery should have a mouth wash of a dram or two of alum in a pint of water, and a dressing outside of boracic ointment. Watering from a separate bucket should not be forgotten. After two or three days without slavering he may be considered safe to return to the company of his fellows.

Dentition troubles have to be reckoned on with the young. Any quidding or slavering should lead us to examine the mouth with an electric torch while pulling out the tongue, first on one side and then on the other. A loose milk tooth, or one caught between two permanent ones, may stick up above the level and prevent the lateral movements essential to proper mastication. The middle-aged horse in his most useful period is not very liable to teething difficulties, as the wear is regular and the grindstones are kept in repair by the constitution of the molars in layers of different degrees of density. Sometimes it happens that their composition is imperfect, and a defective tooth wears away too soon, or has one side that does not undergo regular attrition because it does not meet its fellow. Anything which hinders complete attrition leads to overgrowth. We have known restricted movements due to a head collar too tight in the face band, compelling the wearer to restrict the lateral movements until a habit of so doing has been established, and as a

result the outer edges of the upper row of grinders grow sharp and wound the cheek, and the inner edges of the teeth of the lower jaw have the same defect, with the result of wounding the tongue.

Dental defects in animals have not received as much attention from the veterinary profession as they deserve, and irregular practitioners of widely different degrees of capacity have taken up the subject, some of them inducing owners to believe that many and expensive operations are necessary. Inspection of the teeth and filing off the sharp edges in the case of elderly horses from time to time is desirable, but much else of the horse dentist's art is artfulness.

Failure to pass down a pellet or morsel of food is commonly referred to as choking, whether the lodgment is in the pharynx or back of the mouth, or in the canal we call the gullet or œsophagus. The symptoms in such nervous animals are usually recognised by anyone seeing them for the first time, and need not be described.

Those accustomed to cattle and the use of the choke-rope or probang are warned against the rash employment of similar means in the case of the horse. Unless the case is very urgent, and threatening suffocation, the operation should not be attempted by anyone but a veterinary surgeon, as the gullet is relatively small, and the terrified animal difficult to control and liable to injury.

It may be said here that resort to the probang is commonly too precipitate in the case of cattle, and that any choked animal may be allowed considerable time without serious risk, in which the pellet may pass naturally, or the more urgent symptoms be diminished as the first fright abates. Repeated small doses of linseed oil serve to soften the mass, if it be a wetted lump of meal, a morsel of dry forage, an apple, a piece of mangel, or a turnip, and not a foreign body such as a bramble or a stone. Many cases are self-cured by the redundant saliva that is partly swallowed as well as ejected from the mouth. It is sometimes possible with a gag to discover and remove a "choke" from the pharynx with the hand. A bulge in the neck indicates sometimes where the foreign body is arrested, and manipulation from outside will then give just that little aid which is all that is generally required to pass on the obstructing substance. Low chokes are the worst, and for these the probang may be required. There should be time to obtain professional assistance while the oiling recommended above is being tried.

The layman commonly attributes all failure to digest as due to the stomach. It is a very wonderful organ with powers as yet but dimly understood by the most advanced physiologists, and many views are formed as to these powers and functions. We have a

great literature of dietetics as well as digestion, but the analyst and the physiologist have not discovered the nature of the influence we call life. Artificial stomachs are interesting things, and have taught us a good deal. Experiments conducted in the laboratory with feeding substances employed under conditions of temperature, and even of rhythmical movements resembling those of the muscular contractions of the living organ, have given results from which varied conclusions have been drawn. Chemistry is at once a good servant and a deceiver, because it is a positive science, yet takes no account of vital processes too subtle to be measured or weighed. A week's rations in the waistcoat pocket can be proved to be quite possible by compounding a compressed and concentrated food, but nature insists on bulk, and will return more energy from a pound of apples consisting chiefly of water, than from a tabloid containing many times its value analytically. The tabloid meal has been tried and found wanting.

The graminivorous animals need bulk even more than men do, and in every hay famine or period of scarcity the lesson has to be relearned that concentrated food of greater value theoretically will not take its place. It is useless to think of treating indigestion with drugs if we cannot supply the balanced ration, or the particular demand of the individual sufferer, who may have some idiosyncrasy which leaves him poor and weak on a ration that gives health and vigour to his neighbours.

So far as the treatment of indigestion due to failure of the stomach is concerned, we are hardly removed from the empiricism of fifty years ago. If advance has been made in some directions we have had to acknowledge the practical wisdom of those prescribers who gave sweet pepper and ginger, and fenugreek, and other carminatives or cordials, without being able to say why. We know now that large doses of salts given alone for the sake of economy in drugs do not act well, because the absence of cordials, such as the older practitioners were wont to use in drenches, means the removal of that stimulus to muscular contraction which resulted from such additions.

The present writer's experience leads him to the conclusion that comparatively few cases of indigestion are due to failure either of the secretions of the stomach, or to its imperfect contractions, in the horse, but that to dietetic errors must be attributed most of the cases that the stomach fails to deal with, and that the latter processes of digestion in the intestine are much more liable to perversion than that conducted in the first pouch, or stomach. Stomachic aids are for the most part mere temporary stimulants, and as such

may tide over a period of difficulty. The commoner failure is in the intestines, where the products of the liver and pancreas and of the intestinal glands play so important a part in digestion. To make a correct diagnosis of the particular cause in any single case is beyond the skill of the veterinarian, since he can elicit nothing by questions put to his patient, nor carry out detailed and prolonged enquiries and observations, testing the urine and other excretions of the body. He can only generalise, like his clients, and adopt remedies which experience has proved suitable in other cases. This statement will offend the most advanced students, but it is true. They will have to make many more advances before they can dismiss experience from being the most practical help to the animal owner. Experience tells us that a preliminary purge or clearance of the contents of the digestive canal does good. Perhaps it acts simply by giving the stomach and bowels a fresh start, or by removing food in a state of ferment, or by eliminating toxins. Fasting is one of the cheapest and best remedies for indigestion, provided that a return to food is made in a temperate manner, and only a small quantity of easily assimilable nourishment allowed.

Failure of the liver to secrete its peculiar products and pour them into the intestines is one of the most frequent causes of indigestion in domesticated animals deprived of their liberty, and fed upon too stimulating food, in order to produce energy for labour or meat for our consumption at the earliest date. In the case of horses and other beasts of burden we regulate the amount of energy-producing foods to suit the demands, as far as we are able, but despite our care the balanced ration suited to all occasions is still a theoretical one. An important function of bile is that of an antiseptic or preventative of fermentation in the partly digested food. An insufficient secretion of it may cause scouring, just as excess of it may, because its second function in the canal is to stimulate the movements, or contractions, upon the contents, in a gentle and continuous manner from the time the ingesta leaves the stomach until the waste is expelled from the rectum. That form of indigestion then which is accompanied by scouring or diarrhœa may often be traced to the liver. The horseman should be able to judge whether, by the pale colour and ill-odour of the dung, the animal fails to secrete bile of proper quality and in sufficient quantity, or an excess has caused purging with highly coloured evacuations discharged with biliary fluid. The mouth is often pasty and the membrane of the eye tinged with yellow when the liver is at fault, and the breath has an unpleasant odour. These conditions being present, the owner may resort to the time-honoured dose of fifteen grains of calomel and

four drams of aloes, in the form of a bolus, after the usual preparation with thin or "sloppy" bran mashes; or, if compelled to keep the horse at work, he may adopt a course of saline treatment, such as a dram of nitre and one of table salt, an ounce of bicarbonate of potash, and two ounces of sulphate of magnesia daily in the food. If dissolved in water and mixed with food, these are not likely to be refused, although the last-named is a bitter drug. Many pasture plants are bitter, and this may account for the readiness with which graminivorous animals will take salts.

From what has been said above it will be readily understood how constipation may be due to insufficient bile in the intestine—the absence of its stimulation of the muscular coat of the gut. Either purging from want of the antiseptic influence of bile, or constipation for want of stimulus may result from imperfect action of the liver. Horses with normal liver action may suffer from constipation, because some individuals have a lining membrane which does not secrete intestinal fluid in sufficient quantity. Such animals need more laxative food, a nearer approach to the grasses, which constitute their natural diet; for it must be remembered that dry feeding is quite an artificial condition, and we must not be surprised that a few animals fail to accommodate themselves to it. The opposite condition of that just described gives us more trouble. What is known as the "washy" horse is one whose bowels are commonly lax when in the stable and purged when worked. We meet with them in all classes, but most often in the highly-strung animal of fast paces. One glorious burst of speed, and three days or more in recovering from diarrhœa, is often the lot of the pacer or trotting horse, and of others from whom but one day a week can be had hunting. The sounds associated with an outing will be followed by peristalsis, or unloading of the rectum, and each lot voided will be more liquid than the last. We must not expect drugs to cure such cases, but endeavour by regulation of the diet to exercise a general control. For the habitually constipated we may prescribe cut grass and roots, bran and linseed mashes, and, above all, a constant care to see that our directions are carried out. A stroll through the stable at mucking-out time on two or three days a week will enable us to recognise the glazed, hard, and small dung balls that precede stoppage and other troubles. If medicines have to be given at all they should be employed early, and be of gentle nature, such as linseed-oil and Epsom salts, rather than aloetic-balls and croton-oil and other violent purgatives. The scoured animal may be best treated by a cordial, such as two or three drams of carbonate of ammonia, a dram or two of ginger and gentian in a ball, with half a

dram of opium. Time and rest will restore him, but time will be saved by some such cordial and stimulant as the above.

Of all bowel troubles of the horse, colic is the most sudden in its invasion, and should be always regarded as serious until proved by time to be otherwise. One hears said: "Oh, it is only a touch of the gripes," and we know that many cases recover without treatment of any kind; but there are plenty of examples to the contrary. Colicky pains may arise from other causes than spasmodic or flatulent conditions of the intestine. They are associated with liver and kidney troubles, with stones in the bladder or the intestine, lodgment of foreign bodies, or with true inflammation of the bowels, which carries with it a very high mortality. The horse-owner is warned against working a horse that has shown colicky pains until he has been free from them for a clear day. The symptoms of spasmodic colic are too well known to need description, but the attendant should notice if, with the onset of pain, the flank is blown up or remains normal. True spasm of the intestine comes on more suddenly than flatulent colic; the latter increases with the pressure of retained gases within the bowel, and as a rule the pain is not so acute, nor are there periods of ease between the pinchings. The importance of the clinical thermometer in the hands of the amateur doctor cannot be better illustrated than in colic. The temperature will not be raised if the pain is due to spasm only, but if the pain is caused by approaching enteritis or inflammation, it will rise considerably. This will decide the horseman who has been hesitating as to sending for professional aid. He will be disposed to treat colic with his pet remedies, or accept the suggestions of neighbours, but a case of inflammation should receive more skilled attention. If he cannot get a veterinary surgeon, he may apply mustard to the belly and give a dram of calomel and half an ounce of opium, and wait for advice.

But whatever he gives, the composition of it should be made known to his professional adviser, so that he may not employ incompatibles or neutralise one remedy by another. It has been the custom for centuries to treat spasm of the bowel with opium and other narcotics, combined with alcoholic stimulants, and most cases respond to such medicines, but an uncombined sedative, such as half to one ounce of chloral, has apparently cured thousands of cases in the Army. It acts best given in a ball, but if the ball is broken in the mouth the membranes are blistered and the tongue shares in the mischief, so that for most amateurs a solution in a pint of water given as a drench, is a safer plan. Where there is distension of the flank, due to flatulence, a couple of ounces of spirit

of turpentine in a pint of linseed-oil acts as a stimulant, disinfectant, and destroyer of gas. Such a drench may serve for most colics, as a dose to be kept in stock for emergencies, but if inflammation is present turpentine is not desirable. Improper food or feeding is the cause of colic. Many owners have been converted to watering before feeding, and their horses have ceased to be troubled with colic. —CAPTAIN H. LEENEY, in *Farmer and Stockbreeder Year Book.*

The Fertilising of Oats.—It is very important that the oat crop should be increased. This can be done in two ways—(1) by extending the acreage under cultivation, (2) by increasing the average crop per acre—and it is undoubtedly the case that the yield could be considerably raised by the judicious application of fertilisers. In this respect a glance at the yields in different countries is instructive :—

	Average for 5 years preceding the war per acre.
The United Kingdom ..	43 bushels.
Belgium	56 „
Netherlands	48 „
Germany	44 „
France	30 „
Austria	29 „
United States	25 „
Russia	18 „

It may be noted that statistics show the quantity of fertilisers used in the different countries corresponds with the yield per acre; thus the system of farming in Belgium is intensive and the use of fertilisers relatively greater than elsewhere. The Dutch farmers also employ fertilisers very freely; while in Russia farming is conducted in a haphazard way, and fertilisers in many districts are unknown and unobtainable.

The United Kingdom occupies a place between the top and bottom of the scale. The use of fertilisers and the consequent yield is not unsatisfactory, but it is far short of the possible yield.

We have before us a "report on an experiment on the manuring of oats" issued by the West of Scotland Agricultural College, and the results obtained in those experiments indicate clearly what can be done by judicious manuring. The experiments were carried on for three years on farms pretty widely scattered and on a variety of soils, the scheme being as follows :—Seven plots : (1) No manure ;

(2) 2 cwt. superphosphate; (3) 2 cwt. super and 2 cwt. kainit; (4) 2 cwt. super, 2 cwt. kainit, 1 cwt. nitrate of soda; (5) the same, but nitrate of lime instead of nitrate of soda; (6) the same, but sulphate of ammonia as nitrogenous manure; (7) the same, but nitrolim as nitrogenous manure.

All manure, including sulphate of ammonia, was harrowed in at the time of seeding, except nitrate of soda and nitrate of lime, which were top-dressed when oats had braided.

All the different applications showed an increase, and the best result was produced by the application of super, kainit, and sulphate of ammonia. This is satisfactory, because sulphate of ammonia is the nitrogenous manure now available. It has been considered that nitrate of soda was more especially adapted for oats, but evidently sulphate of ammonia can be used with equal confidence. The average increase produced by the dressing of super, kainit, and sulphate of ammonia over the unmanured plot was 13¼ bushels, the yield being 54½ bushels, with 38½ cwt. of straw.

This represented, calculated at the pre-war price of 20s. per quarter of oats (320lbs.) and 30s. per ton of straw, a profit per acre of 27s. 5d.

At the present time a farmer might well congratulate himself on such a yield, and there would seem to be no reason why he should not obtain it.

The dressing this season cannot include potash; its place should be taken by a dressing of salt, which will liberate soil potash.

There was quite a marked difference in the time of ripening of some of the plots. As a rule, the unmanured plot was the last to ripen, and some of the experimenters reported that it was considerably behind the other plots in that respect.

Of the fully manured plots the nitrolim ones were the first to ripen, being generally a few days ahead of the sulphate of ammonia plots, which came second. The nitrate of soda and nitrate of lime plots were a little later in ripening, but they were always earlier than the unmanured plots.

For the most part the plots kept up fairly well, and there were no complaints about the manuring causing the crop to lodge. In one or two cases the plots did go down, and there is reason to believe that when there is a risk of the crop lodging, if any nitrogenous manure is applied, sulphate of ammonia or nitrolim should be used in preference to nitrate of soda or nitrate of lime, as in the opinion of several of the experimenters the two latter manures gave rather softer straw, which tended to go down more easily.

There is a remark in the report on the advantage of lime, and this

may be especially emphasised in view of the use of sulphate of ammonia :—

> "In order that the oat crop may benefit to the fullest extent from the application of manure, it is essential that the soil contain a fair balance of lime, because of the varied and all-important part played by that substance."—*Mark Lane Express.*

The Grazing of Pigs.—The turning out of pigs into a green field on mild bright days, for a few hours is NOT my idea of the grazing of pigs. Apparently they are more intent on botanizing than on the serious and all-important occupation of taking in nourishment to meet the daily bodily waste, and sufficient for their increasing weight.

They return with the regularity of the Club Habitué, well in advance of the time for feeding.

The *true* Hereditary Grazing Pig knows his business as well and as efficiently as the sheep, and a herd will be seen to graze somewhat after the manner of a flock of Southdowns.

Moreover, the grazing pig commences at a very early age; long before weaning time. He is a discriminating grazer too. When called upon to feed on a wire-like herbage, he makes the best of a bad job by masticating this material carefully, extracting the soft and liquid parts, and expectorating the bulky, worthless, woody, fibrous portions. He recognises and fully appreciates the extraordinarily nutritious value of the thistle, in certain stages of growth, and is a clever chemical expert, in that he prefers the ashes of the thistle to the ashes of grasses; in fact, he can teach us many truths if we are able to learn. He is extremely fond of charcoal, and demands grindable grit, and instinctively includes chalk, limestone, and mortar as part of his medical equipment (and who shall blame him?—assuming his owner to be ignorant of his needs).

Let the occupier of land, especially heavy land, deficient in phosphoric acid, try the effect of liming (or chalking) and pig-folding preparatory to a crop of mangolds, swedes, cabbage, or potatoes, etc., with corn crops to follow. Ascertain the area occupied by 12lb. to 15lb. clover, just showing flower buds. Allow for each hog the aforesaid area. Move forward the ordinary five- or six-slatted sheep gate, always securely set and fixed together, once a day (better twice if labour admits). Given the Hardy Hereditary Grazer and a well-chosen herd of strong pigs, that clover field (at present prices of pork) should give an immediate return of £18 to £25 per acre, or more.

How shall we assess, and what shall we say of the method

which deposits evenly the rich lasting fertilizer without the now dreaded cost of carting and spreading, and the providing of the equivalent?

The pig I write of, from June to September, needs no expensive house—*no* house at all, though four hurdles *per six to eight pigs*, with two hurdles thatched or felted for covering, will form a welcome shelter which can be varied in shape and size in accordance with size of herd, and can be moved and re-erected in less than ten minutes, say once a week.

I appeal to one or more of our agricultural colleges to test the plan, say 50 hogs against 50 sheep, and to publish the immediate result as also that for two subsequent years on the corn crops.

Grass contains all the elements necessary for the development of the growing pig, and for the production of bone and muscle; but, as stock-rearers of all farm animals know, the soil on which the grass grows is an all-important factor.

Most pigs make their early growth upon concentrated food, as their ancestors have done. Grass and clover will not sustain them satisfactorily for two reasons, viz., the inability of their receptive organ, the stomach, to take in a sufficient quantity of the bulky food, and the lack of power of their digestive apparatus to deal efficiently with the extraction and assimilation of that which is required by the young, growing pig.

The Hereditary Grazing Pig is born with the essential *hardy* constitution, the instinct to graze, and the apparatus and the power to deal efficiently, as it grows, with the main source of livelihood, viz., grass and clover. Success can only follow the full and complete appreciation of these facts.

As to the value of pasturage for pigs, Mr. Sullivant's report to the Ohio Agricultural Board is extremely important and instructive, containing the results of experiments achieved at the cost of unstinted efforts.

He calculates that 15lb. of grass will sustain and fatten a hog ½lb. daily, and that during the period of pasturage—the five months May to October—one acre of timothy and clover will give a return of 382lb. of pork. The return from two of my experimental pastures, after deducting the cost of the small amount of purchased food, is nearly £20 per acre.

I turned into a good pasture of five acres eighteen large sows and gilts in April, the same number being kept up until September, during which time not a particle of purchased food was given them; they lived entirely on the pasture. Of course, each in-farrow pig was withdrawn, replaced by another about a week before farrowing.

The litters were satisfactory, and on the average strong. The young pigs throve amazingly.

The pasture had to be "trimmed" from time to time (two or three days at a stretch) by turning in about 120 ewes and lambs, a customary local charge of 4s. per score per week being allowed. The rent (and rates) of the five-acre pasture is put at £10 per annum. The allowance for sheep keep, added to a sum from a charge of 4d. per head per week per sow, produced the rent (£10) in seven months. An abundance of keep remained until severe winter set in.

Dr. Nörner, in his book "Praktische Schweinezucht," gives the results of some experiments in swine-feeding on red clover which show the economy effected by pasturing. On twenty acres of red clover, 120 adult pigs were pastured for 120 days.

If fed in sties in the local way for breeding stock, the cost for the 120 sows for 120 days would work out at £168, whereas the cost of pasturage (allowing 70s. per acre for the clover) for the 120 sows for 120 days is £70, showing a saving through pasturage of £98.

For rapid pork production of the choicest quality such as Southerners prefer, I find small strains, bred specially for their capacity to do most of their work on good pastures and for their power to fatten on almost incredibly small amounts of purchased foods, the most profitable. Of many tests bearing on this important point I will quote one. Three specially bred small sows, each with an average litter, consumed only a third more purchased food than one large sow with a similar litter. At eight weeks old the litters were of about equal value.

I aim at producing three classes or special strains: (1) The porker, (2) the baconer, (3) the dual-purpose sow—a procedure which has been ridiculed, but which, so far, satisfies and pleases me for reasons not difficult to discern.

Perhaps the most valuable and lasting asset of the grazing method is the extraordinary improvement in the value of the pastures, especially on certain soils, if an intelligent appreciation of the soil analysis is acted on. Some of my pastures, worth a few years ago from 5s. to 10s. per acre per annum, would now pay their way at 50s.

A word of warning. It is unwise to imagine, and folly to expect, that pigs, even hereditary grazers, will thrive unaided on all green, "grassy-looking" fields fondly called pastures. If poor, then purchased fertilisers, more or less combined with lime, chalk, or basic slag (where suitable), must be bestowed on the land, after which an almost magical change will be quickly obvious both in pastures and pigs. A. HARBORD in *Live Stock Journal Almanack.*

The Cow and her Health.—In order to be a successful dairyman one must become familiar with the requirements of the dairy cow and methods of disease control. Knowledge in the care and needs of the cow can best be gained by study of the animals themselves, but also by the study of books and the progressive dairy papers. The health of the herd is an important factor from an economical standpoint. By this we mean not only the very serious diseases to which the dairy cow is subject, but also those of a more transitory nature the result of digestive and similar disturbances, for these we believe cause the loss in milk production to be enormous in the course of a year.

One of the most vital agents contributing towards the health of the cow is regularity of the stable work. The regularly fed, regularly milked, and regularly groomed dairy cow is naturally in a more peaceful and therefore more healthful state than the one fed and milked at irregular hours. It is advisable to adopt a system of work and follow it religiously. Feeding of grain can be practised before milking, but hay and other roughage should not be fed until after the completion of milking, as it gives rise to too much dust in the air of the barn, which is not permissible in sanitary milk production. The time elapsing between milkings should be as nearly equal as possible. This is conducive to a more uniform milk secretion.

It has been said that the health of a man's herd is an index to the state of civilisation of the man. This may be the whim of an idealist, yet when one considers that infectious diseases are classified also as preventible diseases, it may bear a deal of truth. The owner is responsible for the health of his herd in so far as type and construction of buildings, care, and surroundings are within his control. By the first of these is meant the provision made for health, as ventilation for example, and for the controlling and eradication of disease should it gain a foothold. By care and surroundings we mean provisions for the animals' comfort, grooming, and the general cleanliness of the stable and yards. The day of the manure-decked dairy cow has long since passed. It is imperative that the cow be kept clean, not only from the standpoint of sanitary milk production, but to protect the dairy industry from slurs upon its good name, and also better to provide for the health of the cows.

There is at least one thing required of all machines in common, whether that machine be a dairy cow or a thing of steel, and that requirement is the all-important one—power. The dairy cow has often been compared to a machine. As such, her power is derived from the three essentials, air, food, and water, and each

must be unpolluted. In the utilisation of food consumed, the blood of the animal is being pumped and repumped throughout the body, doing its work of giving up substances to be used in the nutrition of the body cells and taking up waste products in turn. The most important of these waste products is carbon dioxide, a poisonous gas, from which the blood is freed by aeration in the lungs. For this purpose a big supply of pure air is needed. The objection to efficient ventilation advanced by some dairymen, that an abundance of fresh air makes the barn too cold resulting in a diminished milk flow, and is also injurious to the cow, is not well taken. In fact, experiments have proven that cows kept in well-ventilated stables are more healthy and give a larger and more uniform amount of milk than those kept in poorly ventilated stables. Experiments have shown that the cow requires 3,542 cubic feet of fresh air per hour, and provision should be made for supplying this amount. There are several good ventilating systems in use from which one can select.

The forces or factors concerned in ventilation are as follows :—(1) The wind pressure on the building, which causes air to enter the building by the natural force of the wind. This amount varies, of course, with the velocity of the wind. (2) The wind suction produced on the leeward side of the building. This has a tendency to draw air out of the building. (3) The difference in the inside and outside temperatures tends to cause an interchange of outside and inside air.

Ventilation flues should be of sufficient size and number to provide a sufficiency of fresh air for the animals. A flue 2ft. by 2ft. will supply enough air under average conditions for twenty cows. Two such flues would be necessary for forty cows. Cubic feet of space allowed per cow have no important bearing on ventilation. The cows should have enough room to be comfortable, but excessive space is undesirable from the standpoint of efficiency and economy. Twenty cows should not be given a stable less than 36ft. by 30ft., with a ceiling 8ft. in the clear, or 432 cubic feet of space per cow. Ceilings higher than 8ft. have the disadvantage in the north of dissipating the heat of the stable, the floor always being cold. Where possible the foul air should be removed from the stable at or near the floor, thus removing the heavier waste products of respiration and the foul odours of the stable. This plan also has the advantage of removing but a small portion of the warm air of the stable, which naturally is near the ceiling or roof. It should also be remembered that fresh air coming into the stable from the outside should be made to enter at an upward angle so as not to strike the cow. Draughts should be prevented.

Attention should also be given to the arrangement and number of windows. Light is necessary to provide for the requirements of the animals and the demands of sanitary science. Sanitary milk production demands well-lighted stables, and direct sunlight has been proven to be one of the most efficient means of destroying undesirable microbes. Furthermore, the well-lighted stable is more easily kept clean than the ill-lighted one, because dirt and filth are more easily seen. Basement stables with thick walls need larger windows than buildings of thin walled construction. Long rectangular windows admit more light if the long axis is vertical than if it is horizontal. Windows should run from the ceiling down, rather than from the floor up. As much light as possible should be admitted from the south in order to benefit from the direct rays of the sun.

All buildings should be so constructed that cleanliness is found to be more convenient than uncleanliness. This is possible. Floors are of great importance. Those constructed of concrete are by far the most desirable from a hygienic point of view. They are easily cleansed, and in case of outbreaks of infectious diseases are easily and efficiently disinfected. The same object should be kept constantly in mind in the construction and installation of stable equipment. While feeding problems are more closely related to the production end of the dairy business, proper feeding methods also have a vital bearing upon the general health of the dairy cow. Care and study must be given to the ration. The milk-producing animal should be given a sufficiency of a properly balanced ration to maintain her body weight, and, in addition, an amount of protein, carbohydrates, and fat proportionate to her milk production. Too narrow a ration throws an excessive amount of work upon the liver and kidneys. Cottonseed meal in too large amounts is apt to be the cause of constipation. It has also been accused of being responsible for blindness and other eye troubles in cattle; this, however, still remains to be proven. Wet brewer's grains and wet beet pulp in an advanced state of fermentation are often used to excess and result in a persistent and serious diarrhœa. Fresh beet pulp and like feed in limited amounts apparently have no deleterious effects. Dried beet pulp and dried brewers' grains can be used as an important part of the ration with safety. The excessive feeding of roots has, according to experiments, a bad effect upon the kidneys. The practice of carrying young animals through the winter on dry roughage exclusively, such as corn stover and straw, is bad practice, and responsible for a considerable loss, as they tend to cause impaction of the third compartment of the stomach. Losses are not confined to deaths alone.—*Hoard's Dairyman*, U.S.A.

Sheep-Breeding.—Not within the memory of the oldest have such prices been realised for sheep. Every kind of animal on the farm is nowadays paying well for its keep, but the sheep is the most profitable of all. The reason is not far to seek, inasmuch as the sheep fulfils two purposes, is, in fact, the real dual-purpose animal, not only bringing in to the flockmaster a substantial return in wool and mutton, but is one of the best and cheapest fertilisers of the soil. Mutton has not been fetching such prices for forty years or more, if it did then, and although wool has made more money in days gone by, yet had farmers had a free hand and wool buyers too, we should very probably have seen the high wool prices of the past topped this year. It is, however, necessary to consider the value of sheep nowadays very particularly as fertilisers. We are urged on all sides to grow more corn, but the farms are becoming depleted of labour to such an extent that in some districts farm work will soon be brought to a standstill. Muck carting is one of those jobs that take up a considerable amount of time and labour. It is hard work—far too hard for the average woman or boy to tackle—many horses and carts are required if the manure is to be carted to distant fields, and then there is the spreading to be done. All this can be saved or, at any rate, postponed to a more convenient time by sheep folding.

On clover leys heavy stocking for a time with sheep previous to ploughing will be a great help to the succeeding crop. Where there is a good strong plant of pure clover on heavy land no further manuring is required, but on the lighter soils where mixed seeds are grown the leys can always do with something extra in the way of manure. Where plenty of roots are grown it is an excellent plan to fold some feeding sheep on a stubble when another straw crop is to be taken. The roots can be carted as required, and either thrown about whole or cut for the sheep in the fold, and a good field can thus be manured sufficiently for the crops without the labour of muck carting or the expenditure of large sums in artificials.

Then, again, any stubbles that are cleared early, such as winter oats or barley, can be scuffled and drilled with a crop of mustard and rape mixed with a few white turnips, and by folding the sheep on this the land is prepared for a spring crop, and there is no labour on it other than moving the pen and supplying the artificial food. A great many farmers have drilled a big acreage of kale instead of swedes and turnips this year in order to save the labour of hoeing and singling, and also of pulling and cutting the roots when the sheep come into the folds. A man can soon set the pens, but it takes time to set pens, cut roots and carry corn and hay. Every-

thing that can be done to save labour might be done nowadays. Considering the fact that shepherding takes up the whole of one man's time on any ordinary farm, it is satisfactory to see that our sheep stocks have increased, although it has been, no doubt, a great temptation to many farmers to sell their breeding ewes—now making such excellent prices—thus saving the risk and trouble of lambing, with very probably the prospect of having no shepherd to look after them when that time comes.

It is probable that on many farms where there are swedes and turnips to lift, it will be found necessary for the flock to consume them on the land. Although sheep do better on turnips when they are cut for them, yet they will feed well on roots when they do their own cutting, but they take longer and there is a certain amount of waste—details which must be overlooked in these times, as it is certainly a great saving in labour where roots need neither to be pulled nor cut.

The pulling and clamping of roots is long and expensive work, and then the roots have often to be cleaned before being given to the sheep. It is obvious that all that kind of thing is quite out of the question in most districts, and sheep farming will, for a time at any rate, have to be conducted on a more rough-and-ready system. Crops must be grown for sheep which they can consume on the land without extra labour, and such crops as kale, cabbage, vetches, mustard and rape and so forth will provide a lot of excellent sheep food, and the expense of hoeing, pulling and clamping roots, to be followed by cleaning and cutting up before they are fed to the sheep, will be saved. Then the land will be fertilised at a minimum cost in labour, and at the same time a profitable return in mutton and wool will be assured. The only way, so far as can be seen, to maintain full breeding flocks on arable farms is to let the sheep do as much of the work as possible. It is highly important to maintain and increase, if possible, the number of breeding ewes. Once the breeding stock falls behind in point of numbers it takes some years to get it up again. In 1911, owing to the prolonged drought, our breeding flocks became seriously reduced, and numbers were only just coming right again when the war began. If our breeding stocks are allowed to decline, or if instead of keeping a wet flock farmers are induced to sell out and maintain a dry one, we shall soon feel the shortage, which will be a serious matter for the country. It is a question of labour. If a farmer finds himself with no prospect of a shepherd to lamb his ewes, and he himself has to take a man's place on the farm in order to carry on at all, it is very tempting to give up a breeding flock and run store sheep.

From the labour point of view there is, after all, considerably less labour on sheep than on cattle during the winter. Cattle of nearly all descriptions must be housed and fed twice or thrice a day, yards and stalls littered, and so forth, whereas a number of store sheep will run about the fields requiring nothing but a look round once a day unless hard weather sets in. Whether flocks be dry or breeding, farmers will be very ill-advised not to do all in their power to keep up to the present level their sheep stocks, for so profitable an asset on the farm as the flock should not be diminished in any way.

Store sheep of all descriptions have met a ready sale, and there is no prospect of prices becoming much lower for some time to come, so that the sheep-breeding industry is certain to continue to be for many years the most lucrative branch of farming.—T.B.G. in *Farmer and Stockbreeder.*

Wintering Cattle under Cover.—The climate of the greater part of these Islands is such as to render it imperative that the larger portion of our cattle stock be kept through the winter months under cover of some description. In the extreme western parts of the country the climate is more equable, and all classes of stock, unless they are quite young calves, can be wintered out of doors without any risk whatever, if necessary in the interests of economy. But in the Northern, Eastern, and Midland districts, and in the South also, it is necessary, with some few exceptions, to provide shelter, at any rate during the night and in the harder part of winter, for practically all classes of cattle stock.

The provision of suitable shelter for the cattle stock must be studied from a practical as well as an economic point of view. It is necessary, before bringing a whole lot of stock into the yards, to study the resources of the stackyard, and how far the stocks of hay, straw, roots, etc., are likely to go. On the other hand, from an economic point of view, it is important to take into consideration the increased gain in live weight of stock wintered indoors as compared with those which are out-fed. The expenses of wintering cattle under cover are naturally somewhat higher than those of out-feeding, but it will be found, especially in the case of young animals, that any extra cost is much more than repaid by the increased gain in growth and weight.

Our seasons are so uncertain and irregular that no one can tell with any degree of certainty when he may be forced to begin winter rations and to provide shelter for his stock. Our winters are generally long and cold, and the sharp twinges which we get in mid-autumn come as a gentle reminder that our animals require shelter.

Even should the winter be mild, the vicissitudes of the weather are all against the maintenance of dairy cows and all animals under three years old, out of doors, with any degree of economy.

There are various ways of keeping cattle through the winter under cover, and the way in which the animals are fed and otherwise treated must depend on their age and what is required of them in the following spring. Cattle which are placed in yards and boxes for the purpose of being fed into beef are not the subject of this article, but the thousands of breeding and store animals, which must needs be carried through the winter for the dual purpose of consuming the winter keep and for grazing during the summer months. Whatever method may be adopted with regard to older bullocks and off-lying heifers, it is at any rate essential to provide suitable cover for all young calves and yearlings and milking stock.

The wintering of young cattle under cover has been proved, by experiments conducted at various times, to be by far the more profitable method, even in districts where the climate will permit of out-feeding through the winter months. An experiment conducted some years ago in Ireland, where the climate is very different from ours, proved that outlying calves only increased 7lb. per head in weight from December to May, whilst in-fed calves increased 140lb. during the same period. Besides, the actual cost in food when young animals are in-fed is really not much in excess of the cost of out-feeding, inasmuch as in out-feeding a larger amount of concentrated food is necessary to help to maintain bodily heat; and, moreover, a very considerable quantity of hay must also be consumed in the case of young animals, especially in severe weather. Although there is but little expenditure in labour, there is, on the other hand, too small an increase in live weight to pay for the amount of dry food consumed on the grass. Where the same class of animal is wintered under cover less concentrated food is required; good oat or barley straw can, if necessary, be substituted for hay, which need only be fed in very limited quantities, and not at all if a small supply of roots is provided. There is a gain in live weight of twenty times more than in the case of out-feeding. Further, the manure can be put down as a set-off to labour and attendance. With regard, therefore, to young animals, calves and yearlings, experience proves to be in favour of in-feeding during the winter.

A run out of doors in the middle of the day affords the advantage of air and exercise, but, if cattle are allowed to remain out too long, to starve round gateways for hours waiting to come in, there is considerable loss in condition. Although animals treated in this way may make a quicker start on the grass when it comes, yet, increase in

weight and value will be all in favour of those animals which have been kept in the yards night and day.

Stronger store cattle, such as two and three-year-old bullocks for summer feeding, and heifers and breeding cows, with the exception of old bullocks, require shelter of some kind, and are more profitably maintained under cover. On practically all mixed farms there is a considerable amount of straw and fodder to be consumed and trodden into manure ; and except on the large root-growing farms, where winter feeding is extensively practised, the majority of the cattle are wintered for grazing purposes. Hence, in the spring, nice, healthy condition is of great importance, whether the animals are to be sold off or grazed on the home pastures.

In the case of grazing cattle it is not always the best policy to put them on to the grass in over-fresh condition. When they have been wintered indoors altogether the change from the warmth of the yards to the cold spring nights, and from dry food to young succulent grass, cause a considerable shrinkage, which takes them some little time to recover from. When wintered under cover the majority of our grazing cattle have to put up with "store" fare, and in most cases a foddering of good straw night and morning with four or five pounds of cotton cake a day, and water *ad lib.* form the winter rations ; and although on this fare there is not so great an increase in weight as when roots or hay form part of the ration, yet the cattle generally come out in good condition for the grass, and go ahead without any check. But when wintered in this way they cannot be expected to make early summer beef. When the latter is the desideratum, it is advisable either to feed a ration of roots in addition to the straw, or otherwise to substitute hay for the straw ration ; then, a considerable improvement in condition and weight will be noted in the spring, over those animals which have been wintered on straw and cake only.

A system which is much in vogue in some districts is to give the bullocks a run out of doors in the middle of the day, and feed them with turnips, straw and cake, night and morning, in limited quantities. Cattle wintered in this manner are usually half fat when turned out to grass, and make good beef by the end of June or early July.

There are many big grazing farms consisting entirely of grass on which it is impossible to winter stock under cover. A common practice on these farms is to make a good hayrick or two in the middle of any fields which are mown, keep the cattle out of the aftermath until the approach of Christmas, and then turn them in to consume the hay on the grass. Three-year-old bullocks winter out

very well indeed on this method with the assistance of some cake. For those cattle which cannot be kept in this way straw-yards are hired in some of the big arable districts. Even older cattle wintered out cannot be expected to make such increase in weight as do those which have the advantage of shelter, for the simple reason that a great proportion of the food consumed goes to maintain the heat of the body, and in severe weather there is little or no margin left for flesh-forming purposes.

For out-feeding there is a great advantage in hovels of some kind, so that the cattle can consume their hay and cake under cover; and, moreover, instead of the droppings being deposited all round the hedges, leaving in each field two or three acres of rank, sour grass, the manure is all, more or less, deposited in and around the hovels, and can be carted and spread about the land in a proper manner. From an economic point of view there is no question that wintering cattle under cover, or providing shelter of some kind, has a considerable advantage. Whatever class of stock is exposed to the rigours of our winters, when spring comes there is practically no increase in live weight to set-off against the amount of food consumed. In the case of young animals there is not only considerable risk of loss from colds, chills, lung troubles, and so forth, but also —except in districts where the climate is uncommonly mild—they are certain to lose very considerably in condition and weight, and very often receive such a check that they lose practically a whole year's growth. When cattle are wintered under cover they have the advantage of warmth and a dry lair, and the food they consume is turned to good account. Ordinary store cattle in the strawyards can consume many of the products of the farm which are not good enough for feeding cattle or dairy cows. Barley chaff and cavings, oat flights, and the cavings from any kind of straw which may be threshed, the tops and bottoms of hayricks, and so forth, all do very well for store cattle to browse over. They need a few pounds of cotton cake, or, in normal times, damaged or low quality grain can be ground and fed to them. Roots may or may not be given, according to circumstances, but the addition of a few roots to the ration will greatly add to condition and growth.

Another advantage from in-feeding is the value of the manure on the farm. This will more than compensate for any labour bestowed on store cattle, and although the manure will not be quite up to the standard of that made in the feeding courts, yet the consumption of a certain amount of concentrated food, with perhaps a few roots, will give it good value.

For wintering store cattle open yards are preferable to covered-in

courts. Although the latter effect a great saving in litter, and the manure is of far greater value, yet the welfare of the animals when grass comes must be considered. Nothing causes animals to lose condition more quickly than to be sent from warm, comfortable quarters to face cold nights and cutting east winds, in early spring, on the grass. Where the animals have the run of a good-sized open yard, with a shed facing south, they get the benefit of the sunshine when there is any, whilst the amount of air and exposure to rain which they get in the open yard's helps to keep a good coat of hair on, which acts as a protection against the weather when turning-out time arrives.

There is no more unprofitable method of stock-keeping than to expose animals to undue hardship. There are some breeders who seek to maintain the health of their herds and to keep them free from tuberculosis by exposing their breeding cows to undue hardship out of doors through the winter. Out-feeding in these cases ends in the survival of the fittest, and by that means those animals of the more robust constitutions can soon be detected from the more delicate ones, which very often go wrong. But robust health can be maintained in a breeding stock without undue exposure to all sorts of weather. So long as breeding animals have plenty of fresh air and sunshine, and are not allowed to mingle with unhealthy animals, they will attain greater size and more wealth of flesh, and produce far stronger and more healthy calves, when provided with proper shelter and food, than when left to rough it under all conditions out of doors. Warmth, light, and air are the three great essentials for the preservation of the health of cattle wintered under cover, and so long as they get these, with a reasonable quantity of good food, they will make satisfactory progress in return for the cost of their maintenance, and show a considerably greater profit in spring than those which have been out-fed.—"T.B.G." in *Farmer and Stock-breeder Year Book.*

Women's Rural Institutes.—Mrs. Alfred Watt, M.A., of British Colombia, in a lecture on this subject in Edinburgh, referred to the great debt which Canada owed to Scotland. At the first meeting to form a Women's Institute, which was held in Ontario, four out of the ten present were of Scots descent. One of the things which Canada had learned from Scotland was the value of education. The education of rural women was as important as the education of any other citizen. The education of rural women was a part of rural development. The home was the foundation of national prosperity. The first aim of the Institutes was to try to make the home a better

place, and that could only be done by the people who lived in the home. Improvement of the home must come from within, from the people who live in it. The second aim was the improvement of neighbourhood conditions—the betterment of social life. This involved many considerations connected with rural amenities, means of transport, the application of scientific methods to farm and dairy practice, and generally a better social order. The third aim was the improvement of the conditions of agriculture. Woman in Canada had not played an active part in work in the fields. She had devoted herself to the home and its surroundings, and her skill and success there frequently meant the difference between scarcity and plenty of ready money in the farm home. These then, were the three aims of the Institutes—better homes, better social conditions, and better business. How were they to attain these ends and objects? By holding monthly meetings at definite dates and regular hours. During the whole history of the movement in Canada she had not known of a Women's Institute being a failure. They should try to abide by the methods which had achieved this success. The monthly meeting was a cardinal element. That meeting was partly social, partly educational, and it was also something of the nature of an industrial exhibition. The lines of organisation were very simple, and they were also very broad. In Canada these Institutes were supported by Government. They considered economical, social, and educational interests affecting women in small communities. No two programmes were absolutely alike. It was one of the best and most interesting features that what was explained at one meeting as a new and valuable method of doing some domestic duty was made the subject of exhibition at the following meeting. Thus if at one meeting an explanation were given of the method of preserving fruit without sugar, at the following meeting those who had put the method to the test would exhibit the result. At present, in the Institutes in England and Wales, and also in Canada, they were of necessity concentrating on war work, food production, and food economy. That was, they all hoped, a temporary phase. Under post-war conditions they would have many new problems to face, and there would be abundance of room for local development. There was a place for every woman in Institute work. A place for the old as well as for the young. They got the young girls when they had just left school, at the stage when it was so easy to forget what they had learned. They regarded housework as the most important thing. A great deal of wisdom was lost through the older women thinking there was no place for them in the social order—that they had served their day.

It was not so. They could find ways of putting their ripened experience at the service of those who were younger.' Their Institututes were entirely democratic. Everyone paid exactly the same subscription. The element of patronage was wholly eliminated. Unless the women in a district wished an Institute, they did not attempt to force one on them. Another necessary thing was that they must be representative. Every sort of person in the community must find a place in them. Some of the results were these. The social interests of the community were organised. This was of considerable economic value. They helped one another. Every short talk or lecture must be followed up by results. They aimed at being extremely practical. While their ideals were spiritual, their methods were practical. They did not ask, What can I get out of it ? but, What can I put into it ? What have I got in my home to show to others which might be helpful to them ? When these ideals were realised there must be better homes, better social conditions, and better farms. They had an increase of neighbourliness and mutual help. They could not preach sisterhood and not prove it in their lives. In Canada the Women's Institutes were entrusted with all the war work which it fell to women to organize. They were told that it would be Canada's work to grow more food for the Mother Country, and that in itself had justified all the claims made on behalf of the Institutes. Such questions as the work in the garden in the month, or how children can help in the food supply, and seasonal topics generally were considered. They had also a suggestion box. They aimed at developing the principle of co-operation in small communities. In England they worked in connection with the E.A.O.S., and found this very helpful in showing them how to dispose of the extra produce of their gardens. A principle underlying their work was the importance of seeing things, for country people learned more through their eyes than through their ears, so there was always something at their Institute meetings to be seen. Farmers' Institutes and Women's Institutes could work hand-in-hand. There was great need to co-ordinate many things—*e.g.;* emigration. The Mother Country and her Dominions could be mutually helpful in organising this movement, which in the past had been conducted haphazard. When the soldiers came back there would be serious problems for them all to face. They wanted these brave men to come back to a better land than they left. The Women's Institutes would give them a welcome and their wives a welcome. They wanted to try and make the country a better place for women to live in. The hour of meeting had to be determined by local circumstances. They

found 2.30 a good hour in Canada, or between tea and the supper hour. The annual subscription was invariably 2s. The size of the area embraced depended on geographical conditions. In Canada many had to come long distances, yet they would not miss the meetings for anything. They got assistance in the way of addresses whenever possible, and preferred to use local talent first: it drew out their members' own gifts. Sometimes they got speakers from headquarters. So far as sparsely populated districts were concerned, it was in these that the greatest need for the Institutes was found.—*The Scottish Farmer.*

Pasture Improvement.—It is a generally accepted belief amongst those who give much consideration to the subject that food shortage will continue throughout 1918, and for a considerable period afterwards.

"The productive power of the soil of Europe," says Mr. Prothero, "is failing. The yield per acre in 1916 fell; for 1917 it has fallen, and there is every prospect that there will be another fall next year. That being so, 'peace and plenty' may be a mischievous delusion." Personally, I would go further and say that the latter is out of the question for years to come.

"In my opinion, there has been far too much indiscriminate ploughing up of grass land.. Most practical agriculturists will agree that, while all patriotic farmers are ready to strain every nerve to produce more food in one shape or another, yet to plough for the *sake* of ploughing and the creation (on paper) of a record increase in the arable area is "worse than wicked; it's foolish."

Speaking for the immediate present, it is agreed that the 1917 harvest was very late and protracted, and that stubbles are very foul in consequence of lack of labour and heavy rains. In fact, does any farmer ever remember the land in so foul a condition? If most farmers experience a difficulty in handling their present arable, what can be the state of the land if extra arable is added? Feeding stuffs are dear; therefore more than ever the cheapest food for stock is grass. And stock means more than the popular idea of beef and mutton! What about butter, cheese, milk, hides, wool, etc., of the shortage of which the country is painfully aware, even if it is not cognisant of the contributory causes?

While to come under the Ploughing Order is the very best that could have befallen some poor grass land, it is unfortunate that the really good fattening pastures, of which all of us have concrete examples in mind, should be broken up. They can do no more than produce ordinary grain crops, or crops which, if better than ordinary

are likely to become laid for that very reason, with the nightmare always in prospect that sufficient labour to harvest them may not be available, or that the weather may be disastrous. Another wet season and late harvest would, to use the vernacular, "put the lid on it," and in the meantime, be it noted, the pasture has been lost for grazing purposes.

What also of the case of the man in the Weald of Kent, or on the slopes of the Cotswolds, who has pastures of indigenous wild white clover—possessions which, as I shall endeavour to show later, are almost priceless in view of the formation of new pastures depending on this humble little plant with the long botanical name, and the equally long price per pound (though not per million potential plants)?

Not many Parliamentarians or statesmen have displayed the foresight shown by Captain Sir Charles Bathurst, when he wrote quite twelve months ago:—"Upon the production of human food as a prosperous commercial enterprise hinge all other benefits, physical, social, and economic, summed up in the expression agricultural reconstruction. But such enterprise requires skill, foresight, and sound knowledge, based upon scientific investigation and experience."

Take the question of the improvement of pastures which, though for one reason or another are not under orders to be ploughed, yet are distinctly not contributing their fair share to the food production of the country. Like the three famous M's, "Men, Munitions, and Money," three means are also available to this end, viz.,

(*a*) Mechanical.
(*b*) Manurial.
(*c*) Mixtures.

(*a*) Mechanical.—Considerable improvement of pastures may be attained by purely mechanical means; toothed and disc harrows being the implements available, the former for the tearing out of moss and the latter for the slicing up of the old turf, resulting in beneficial aeration of the soil. Draining may often be undertaken with an equally beneficial result when the land is wet and sour.

(*b*) Manurial.—Where the pasture has received no manurial treatment it naturally becomes poverty-stricken and unable to support first-rate pasture plants. Then bent (*Agrostis vulgaris*) comes into its own, and the stock-carrying capacity of the pasture decreases rapidly. Apart from farmyard manure, the supply of which is limited, the application of phosphates, or of lime in one of its forms is often very successful, and outstandingly so in the

case of basic slag on poor, heavy clay soils. A combination of this manuring with the treatment described in (*a*) would doubtless show a still further improvement. But no amount of manuring can change second-rate pasture plants and weeds, which constitute the bulk of the herbage, into first-rate pasture plants.

(*c*) APPLICATION OF SUITABLE SEED MIXTURES.—This course in the past has been a chance experiment, and only to be recommended when, for one reason or another, ploughing was out of the question. The advent of the disc harrow and the recognition and appreciation of wild white clover have thrown an entirely new light on pasture improvement and renovation by seed mixtures, and taken in conjunction with (*b*) and (*a*) may be said to be the A B C of pasture improvement.

The maximum production of grass possible for this poor pasture land cannot be expected until the land is occupied with more productive and better quality pasture plants. The advantage of the modern method of seeding land down to pasture is that, with care and skilful grazing, the better plants hold the ground and prevent the second-rate pasture plants and weeds from gaining foothold.

The correct procedure of renovation is important, and may be outlined as follows, due allowance being made for abnormal cases. Either in early spring or autumn severely harrow and scarify the field lengthwise and across, to tear out the old moss and help to provide a tilth. Follow with the disc harrow in a similar manner, or diagonally, giving the field such a gruelling that practically no traces of green turf are apparent. Then, as soon as the ground is in a fit state, sow the following mixture per statute acre :—

2	lbs.	Italian Ryegrass
3	,,	Perennial Ryegrass
2	,,	Cocksfoot
2	,,	Timothy
2	,,	Meadow Fescue
½	lb.	Rough-stalked Meadow grass
¼	,,	New Zealand Fine-leaved Fescue
1	,,	Late-flowering Red Clover
½	,,	Wild White Clover
1	,,	Trefoil
⅛	,,	Birdsfoot Trefoil
½	,,	Chicory
⅛	,,	Yarrow
15	lbs.	per Statute acre

Harrow the seeds in lightly, and roll firmly. In sowing the seeds difficulty may be experienced in setting the machine to sow so small a quantity, while if broadcasted it is morally certain that the ordinary farm hand will not sow evenly (hand sowing being practically a lost art), but find when he is half done that the seed is all gone. In either case, by adding bulk to the mixture with fine sawdust, the machine or man will deal much more evenly with the sowing, which is also clearly visible on account of the added matter. The best plan of all is to divide the increased bulk into two ; sow half lengthwise, and half across the field, unless the configuration of the ground forbids such a course. Should the first sowing have been a little too meagre or too generous, due allowance can then be made in the second sowing, which crosses the first application. In the result, all blanks, and probably all overlapping, are avoided, and a really even distribution is effected. As up to 40 acres per day can be sown by machine, it is worth while going to this trouble to secure the desired end. The foregoing operations can be conveniently followed by the application of superphosphate or basic slag, according to time of year or analysis of soil, and with anything like favourable weather conditions, a wonderful improvement in herbage may be confidently anticipated.

The late Mr. Elliot evolved what has come to be known all over the world as the Clifton Park System of Farming. This system covers the whole rotation of cropping, but the portion which concerns us immediately is that dealing with seed mixtures. Briefly, his plan was to make use of such grasses and clovers and forage plants as afforded the most plentiful and nutritious grazing, and which possessed, in addition, powerfully penetrative roots, capable of withstanding the severe droughts which might be expected every third year on the Cheviots. Cocksfoot, tall oat grass, burnet, chicory, kidney vetch, and late-flowering red clover are amongst the plants which Mr. Elliot employed ; but the extraordinary success of wild white clover had not been brought to his notice. In fact, very few were then aware of its capabilities, and those farmers who did know were quite content to keep the knowledge to themselves !

Last year aprominent Irish agricultural instructor said : "I have made up my mind about one thing—to make a success of laying down land you must have wild white clover."

Supplies of the grass and clover seeds used in the Elliot mixtures, and supplies of wild white clover, are now provided by most first-class seed houses. Unhappily, they are limited at this period, as are so many necessities, and economy in use is of pressing urgency.

Still, it is matter for gratification that supplies will go far to permit farmers to lay down pastures for at least three years' ley, which would seem to be a happy mean—not too long to limit re-ploughing, nor too short to give great manurial value to the turf when ploughed under. It is hardly necessary to emphasize the great importance of securing fully guaranteed seeds, if a really satisfactory result is to be anticipated. The art, of course, consists in calculating the proportions of each variety of seed with a view to making the pasture attractive to stock, at the same time causing them rapidly to put on weight.

Thirty-five years ago, when many of the farm seeds sold were of very inferior quality, the system of guaranteeing the purity, genuineness and germination of all farm seeds was inaugurated and resulted in a great improvement of the farm seeds sold throughout the kingdom. Seventeen years later the then Minister of Agriculture (the Right Hon. R. W. Hanbury) appointed a Departmental Committee to make enquiry into the subject. The report of the Committee presented to Parliament declared that the improvement in the quality of these seeds during the preceding twenty years was universally admitted ; and they recommended the establishment of a central seed-testing station under Government auspices. Our Government has taken a long time to make up its mind (if it ever gave the matter a thought), but at last, in the fourth year of the war, the Testing of Seeds Order of 1917 makes it compulsory for a seedsman to declare the purity and germination of the seeds he exposes for sale.

At present no standard either of purity or germination is laid down, which, whilst fair to those traders who deal in cheap seeds, the purity and germination of which is necessarily low, is fair also to those houses which have striven to attain the highest standard. In other words, for the first time the latter are to receive due credit for the goods they are supplying, and the user will benefit by being able to check the productive value of the seeds he buys.

A few words on the subsequent treatment of the pasture are necessary.

To the young seeds during the first autumn, apply 5 to 10 cwt. basic slag per acre, if this has not been given at time of sowing the nurse crop.

Graze the young seeds after the corn is carried. This will help to consolidate the soil, thereby greatly benefiting the clover. Let the pasture stand for hay the next summer, by which time the plants will be established. Mow rather too early than too late—if the grasses run to seed they are naturally weakened. Graze the

aftermath as hard as you like, with occasional rests of a fortnight, if the pasture gets very bare indeed. This hard grazing will encourage a close sole of grass, and a fresh supply of succulent herbage is available.

As the pasture will be carrying a lot of stock it will be necessary about the third year to help it with a dressing of slag to replace the phosphates and lime removed by the young stock in the building up of their frame.

If the foregoing treatment follows the sowing of suitable seeds of the best quality, it will prove a most profitable expenditure. The effect of a wide application of the principles set forth will be far-reaching, and the results cannot be other than beneficial to agriculture in general, and to the improvement of pastures in particular.—C. P. Hunter in *Farmer and Stockbreeder Year Book.*

Soot.—The excellent results obtained from soot applied as a top dressing have been known for a very long time, certainly more than a hundred years, as in the earliest agricultural literature favourable references are made to it.

Its effect on crops is produced by the ammonia it contains, though other minor advantages may be attributed to it. Among these minor advantages may be put its nature to check attacks on young, growing crops by pests, such as slugs and snails, which have a strong dislike to the sooty substance. Another advantage is its favourable action on the physical condition of cold, heavy soils, and also the fact that by adding a darker tinge to the soil, it enriches the soil's capacity of storing and retaining warmth.

It should be pointed out that soot contains no phosphate or potash, so that crops to which it is intended to apply soot should also have a dressing of phosphate. In the Board of Agriculture Journal, in a report on market gardening, there is a note of an experiment on manuring potatoes in which a dressing of soot is tested against a complete manure composed of sulphate of ammonia, superphosphate and potash, with the natural result that "the artificials proved themselves vastly superior to the soot." A fair test would have been to test the soot against sulphate of ammonia alone, or else to add to the soot the same quantities of superphosphate and potash.

The crops to which soot can be used with most advantage are probably grain and grass, though it is a good nitrogenous application to any crop. Applied to young wheat and oats, it gave in some experiments an increase of about ten bushels per acre. Tried on carrots, 56 bushels of soot mixed with six bushels of common

salt gave a larger crop than 24 tons of farmyard manure and a dressing of bones.

Thus from a general point of view it is a dressing to be recommended, especially in view of the high cost of other nitrogenous fertilisers. There is, however, a drawback to its use in the uncertainty of its quality.

Good soot contains about 4 per cent. of nitrogen, and should be light in weight. The following analyses illustrate its variable nature :—

Domestic soot	4·09 nitrogen
Boiler soot	1·18 ,,
Dining-room chimney soot ..	5·05 ,,

To increase its weight, unscrupulous vendors have been known to adulterate it with sand, which cannot be detected by its appearance.

Thus soot may be classed as good, bad and indifferent, the good containing 4 to 5 per cent. of nitrogen, the indifferent from 2 to 3 per cent., and the bad from 1 to 2 per cent.

The weight per bushel of soot is a good indication of its quality. Good soot, which is always light, weighs about 28lb. to the bushel, inferior qualities are heavier. This is a test which should be applied by the buyer, who should also stipulate for a percentage of at least 4 per cent. nitrogen—he should make sure that the soot is domestic soot, and should deal only with a seller he can depend upon not to sell adulterated goods.

An average dressing is 30 to 40 bushels, though on heavy, tenacious land larger quantities may be applied with benefit.

In the Journal of the Board of Agriculture are the following remarks about soot :—

> "In view of the great value of soot as a spring dressing for common, heavy land, especially if the winter happens to have been wet, farmers would be well advised to ensure having their spring requirements in sight. A reasonable price for soot would be 9d. per bushel, assuming that it contains about 4 per cent. of ammonia or 1lb. of nitrogen per bushel. It is only ordinary household soot that comes up to this standard."

—*Mark Lane Express.*

Milk Standard Reforms.—Mr. James A. Reid, solicitor, Airdrie, in a lecture to the members of the Glasgow and West of Scotland Agricultural Discussion Society, said the shortage of milk throughout the country at present was leading to many fresh developments in the milk industry. The great tendency was towards combination.

The Public Health Committee of Norwich, for example, were engaged in devising a municipal scheme of milk supply for the city. In the opinion of the committee, the ideal scheme was that the Corporation should acquire the necessary milk supply direct from the producers. It would be received at the central depots, where it would be tested, prices being fixed according to quality. Distribution would be carried out by licensed retailers in prescribed areas. The milk having been analysed, inspectors would, as now, take samples from the vendor on his round, and where it was found to be tampered with his licence would be endorsed. By this scheme the committee estimated that a reduction of 50 per cent. might be made in the number of horses bringing milk into the city, to say nothing of the carriers who followed one another round the same streets. After some opposition the scheme had received the consent of the majority of the 150 milk sellers of the district, and was expected to commence immediately Government sanction was obtained. Whether Parliament would inaugurate this or any similar scheme generally throughout the country when the war was over remained to be seen, but something of the kind might be attempted. If it were it might well involve a solution of the problem of the milk standard on totally different lines from past attempts, but with such more or less probable, distant, and controversial solutions they were not now concerned. For their present purpose they assumed that the controversy about the existing so-called " standard " would continue to be fought out on the old lines for some time at least.

Before 1862 the law of food adulteration was confined to only a few articles, such as bread, tea and coffee. The 1862 Act made it an offence for any person to sell as pure and unadulterated any food or drink which was adulterated or not pure, excepting spirits, which could be substantially reduced in strength, and this, as was known, was still possible. Only a private buyer, however, had power to prosecute, and on conviction the seller could be fined not more than £5, and either party could be ordered to pay the costs of the prosecution. In 1872 the Act was amended to include drugs, the penalty was increased to £20, and, finally, the power to award costs against the accused was confirmed. Following the report of a Select Committee, Parliament in 1875 repealed the Acts of 1862 and 1872, and passed the first of the existing Acts, which provided generally—and this was still the vital provision of the law—that (with certain exceptions) no person shall sell to the prejudice of the purchaser any food or drug which is not of the nature, substance and quality of the article demanded by the purchaser. The penalty not to exceed £20. For over twenty years this Act (as

amended in 1879) regulated the sale of milk. Its operation was however, greatly restricted by the fact that there was no standard by which to test the genuineness of a given sample. Consequently it became increasingly difficult to get convictions in adulteration cases, and the judge in his confusion very often gave the seller the benefit of the doubt, especially in milk cases. Accordingly, in 1894 Parliament ordered another inquiry by a Select Committee, which extended from June, 1894, to July, 1896, but even it did not suggest a standard. It proposed that a permanent Court of Reference should be set up, and they regarded the fixing of a standard as one of the most important questions which could engage the attention of that body.

No such Court of Reference was set up, but the passing of an Act in 1899 empowered the Board of Agriculture and Fisheries, if they saw fit, and after such enquiry as they deemed necessary, to make regulations for determining what deficiency in any of the normal constituents of genuine milk, cream, butter, or cheese should raise a presumption until the contrary was proved that the article was not genuine. Following on the Act, the Board, in January, 1900, appointed a committee to enquire and report what regulations (if any) should be made for milk and cream, the butter standard being tackled by another committee shortly afterwards. No attempt at standardising cheese had ever been made; for that the standard had always been and still was the consumer's judgment and taste. "What is genuine milk?". Faced with this poser they were landed in ever increasing perplexity in trying to solve it. Let them bear always in mind—and this point could not be too emphatically emphasised—that what they were dealing with was not a manufactured article like butter, but a natural product, the composition of which was naturally subject to considerable variation, from season to season and from day to day. This was true of both the non-fatty solids and more particularly of the fat. The causes of variation were many. The breed, number, condition, and feeding of the cows were all factors of more or less importance. These points had been dealt with by the committee, and collectively and separately they were involved in the question whether a given sample of milk was genuine or not. It was not surprising that many of the witnesses declared that the problem the committee had to solve "well nigh defied solution." Sir George Brown, the veterinary adviser to the Board of Agriculture, said—"So far as my experience of committees and commissions extends, I think they have handed to this committee about the most impossible piece of work that was ever suggested."

When presumptive standards were recommended and adopted by the 1900 committee, a standard for cream was dismissed as impracticable and unnecessary. As regards fat in milk, the witnesses' suggestions fell into these heads, viz.:—(1) Below 3 per cent. (eleven witnesses suggested standards under this figure); (2) 3 per cent. (twenty-one witnesses suggested this figure); (3) over 3 per cent. (three witnesses suggested standards over this figure); (4) seasonal standards were suggested by six witnesses varying from 2·75 per cent. to 3·25 per cent. Relying mainly upon the analytical evidence, six of the committee of eight recommended for whole milk a governing standard of total solids of 12 per cent. Where that total was reached no prosecution would result. Where it was not reached they recommended 3·25 for fat and 8·5 for non-fatty solids. For skimmed or separated milk they recommended a governing standard of total solids of 9 per cent. Mr. Farmer agreed generally with the majority, but dissented from the principle of a governing standard of total solids either for whole or skim milk. For whole milk he favoured a seasonal standard of 3 per cent. fat and 8.5 per cent. non fat for March, April, May and June, and 3·25 and 8·5 for the rest of the year, or even for six months for each set of limits. For skimmed or separated milk he agreed with the majority in fixing 9 per cent. total solids. In a most able report, Mr. Barham agreed with the majority in adopting for whole milk the principle of a governing standard of total solids, but instead of 12 per cent. he recommended 11·75. If this total was reached no prosecution would follow. Where it was not reached he recommended 3 per cent. of fat for the six months July to February, for the other six months 2·75 per cent. of fat, and 8.5 per cent. of non-fat all the year round. For skimmed or separated milk he recommended 8·75 of total solids. All these reports were considered by the Board for over six months, when they made the somewhat startling announcement to an expectant agricultural world that they accepted none of them. Agreeing with the majority and disagreeing with Mr. Farmer and Mr. Barham, they rejected the principle of seasonal standards. Disagreeing with seven out of the eight members of committee and agreeing with Mr. Farmer, they rejected the principle of a governing standard of total solids in whole milk. Agreeing with none of the committee, they fixed 3 per cent. of fat and 8.5 per cent. of non-fat. For skimmed or separated milk they adopted the majority's recommendation of 9 per cent. total solids, but subsequently, in 1912, the English Board abandoned this their own skim milk standard, substituting therefore a standard of 8·7 of non-fatty solids only, which the Scottish Board, as a matter of

course, copied in 1914 without any representative enquiry whatever. Wherein they all agreed—witnesses, committee and Board—and wherein they all differed amongst themselves and with themselves, at first sight looked a bit of a puzzle, but if they studied it long enough not only would they solve it, but they might also see that in the end they all differed to agree, or, alternatively, agreed to differ with bewildering cheerfulness.

In this peculiar way, without further Parliamentary sanction, the much debated milk standard became law. Like the Act authorising it, it was itself a "sort of compromise," evidently intended to please everybody, but ending, as all such attempts usually do, in general dissatisfaction. Let them observe its scope. It affected producers and retailers alike, although retailers who were not producers could meantime protect themselves by a warranty from the producer. It applied to every breed of cows; to every herd, large or small, no matter what the condition of the cows was, how they were fed, or how they were milked. It applied to the whole of England, Wales, Ireland, and Scotland, at all seasons of the year—spring, summer, autumn, and winter. It applied under all conditions of distribution and sampling, and was even subject to analytical methods which, it was said, in some respects were not even yet scientifically reliable. And finally, it was worked throughout the country by Local Authorities and judges who not infrequently were profoundly ignorant of the whole subject. How had it worked? Apart from officials, he did not think anybody who knew its history pretended that it had worked well. How retailers who were not producers would fare after the war might be imagined when he reminded them that, by the recent Dairies Act, the operation of which was at present suspended owing to the war, the warranty defence was abolished.

That the law of the standard as it existed at present needed reform could not be seriously disputed. Certainly those affected by it had never ceased since 1901 to demand reforms. Time and again in England and Scotland agricultural societies of all kinds had pressed for amendments in one direction or another, but all to no purpose as yet. To these requests he now added his own plea for what it was worth. Having considered the subject for a long time and having been much engaged for over ten years in milk cases all over the country, he thought he could fairly, yet modestly, claim to understand the problem in all its main bearings. Close study had brought home to him the difficulties connected with it. In particular, two conflicting interests—the producer's and the consumer's—met one at every turn, and both must be reconciled as far as recon-

ciliation was reasonably possible. That the public must be protected against adulteration in such an all important matter as the milk supply of the nation was fully conceded, but, at the same time traders must not be harassed with harsh and unjust laws. Assuming that no Government solution on totally different lines was in front of them, the main reforms he advocated were these :—(1) He was opposed to the abolition of the standard. Abolition was out of the question, and he who advocated it in his judgment, stood for a lost cause and a forlorn hope. He was equally opposed to a definite fixed standard. He had heard some Sheriffs express a wish for this fancied solution of the question. While solving their difficulties, such a standard would unquestionably operate to the hurt either of the consumer or producer. If a low standard were fixed the consumer would suffer; if a high standard—even the present—the injustice to the producer would be infinitely greater than it was. There was more to be said in favour of the suggestion frequently made that milk should be graded and sold according to quality, but as this question was irrelevant to their present purpose, he dismissed it. He was in favour of the present standard so far as its limits for whole milk were concerned. In his judgment, however, it should be amended to the effect of introducing the principle of a governing standard of total solids which seven of the eight members of committee recommended. In many cases in which he had been engaged the seller was prosecuted because, although the fat was high, the non-fat was low by the standard. That was to say, although the seller was selling milk which, from the public health and commercial points of view, was excellent, and therefore not to the consumer's prejudice, neverthless he was accused of fraud simply because it was deficient, almost invariably to a trifling extent, in solids other than fat. Now, had the governing standard of total solids been in operation, those unjust prosecutions, and doubtless many others, would never have been heard of.

From experience, he was convinced that the cardinal blunder made was in rejecting the governing standard of total solids by which the real value of the milk could alone be tested. The standard for skimmed or separated milk originally was 9 per cent. total solids. In other words, the Board here adopted the principle of a governing standard of total solids, and in this form he had nothing to say against the original standard. But, as already stated, in 1912, the English Board, without any representative enquiry, abandoned it, and substituted a standard of 8·7 per cent. for non-fat only, which the Scottish Board, equally without enquiry, copied in 1914. This was a material and very serious change, for no matter how much

fat might be in the skim milk to the purchaser's benefit, the seller's honesty was tested by non-fat, and not by the real value of the milk. In the consumer's interest, as well as in fairness to the seller, the original standard should be restored. The result of every sample taken for analysis should be communicated to the seller within not more than ten days from the date of sampling, no matter what the result of the analysis might be, instead of, as now, given only in the event of prosecution, and even then not until the last possible day, viz., the 28th day from sampling, when it was served with the summons. The form of certificate at present in use varied, but in almost every case it was calculated to mislead the Court. No certificate should contain more than the actual results. No expression of opinion by the analyst should be allowed. If he had any opinions to express, let him state them in Court where they could be tested by cross-examination. The question of referring the third sample to Somerset House for independent analysis was not unimportant, because it seemed to be the practice of that Department to ask that the other certificates should be sent to them before they give theirs. This practice should cease. If Somerset House was able to analyse their sample they should do so; if they were not able they should say so. In no case should they be permitted to get the other certificates for any purpose whatever.

In all prosecutions the Sheriff Court should be made the only competent Court. Although some of their Sheriffs had egregiously erred in administering the existing law, the Sheriff Court was in every way to be preferred to the Magistrates' Court. In all magisterial cases the Magistrate was himself a member of the authority responsible for the prosecution, and was sometimes even a member of the committee actually authorising it. This state of matters, where it still existed, should cease. The presumption of guilt which the analyst's certificate created seemed reasonable enough in the public interest, but, from the accused's point of view, it frequently operated to defeat justice. Which consideration should prevail was a difficult question. In the complicated interlacing of human affairs it often happened that no harder question could be put than —Is such a line of procedure or of regulation just, or is it not? The presumption of guilt in milk cases was an illustration. On a balance of considerations, he was not disposed to advocate the abolition of the presumption. He feared its abolition would practically mean reverting to the state of matters which prevailed before 1900, and which Parliament decided should end.

But he did advocate a discretionary power being given to the Court to award costs to the accused who successfully rebutted the

presumption. Hitherto this concession, although repeatedly demanded, had been refused on the ground, as stated by high authority, that "it would be contrary to the spirit of the law of Scotland" to allow an award of expenses. For mere authority in itself they cared nothing; what concerned them every time was whether a contention in itself was or was not sound. Having regard to facts, he had no hesitation in declaring that this "spiritual" contention, like many other spiritual things, had no substance. All criminal prosecutions in Scotland were based either on Common Law or Statute Law. Here and now they were not concerned with the Common Law—what concerned them was the Statute Law. How the matter of expenses stood by Statute Law was laid down in the Summary Jurisdiction Act, 1908, which provided that expenses might be awarded to or against any private prosecutor, but should not be awarded to or against any person prosecuting in the public interest unless the statute or order under which the proceedings were taken, directly or by implication, authorized such award. In other words, the question whether expenses might or might not be awarded in a statutory prosecution did not depend upon "spiritual" considerations at all, but solely upon what the Act under which the proceedings took place said. Many Acts expressly or by implication authorised an award of expenses. To name only a few. A person who successfully defended himself against a charge brought under the Cruelty to Animals Acts, the Betting Acts, the Cruelty to Children Acts, the Excise Acts, the Trout Fishing Acts, the Public-Houses Acts, the Road Acts, and the Weights and Measures Acts—in all these cases, which were cases in which the prosecutor prosecuted not privately but in the public interest, expenses might be awarded against him. Before 1875 even the Adulteration Acts, as they had seen, allowed expenses, but the existing Acts did not except to a very trifling extent in very special circumstances. If Parliament could allow expenses to the accused in a betting or river poaching or public-house case, it was difficult to see on what ground the same right was denied to the accused in milk cases having regard especially to the presumption of guilt with which he was heavily burdened. By way of reply to this, it might be said that the granting of expenses would tend to hinder the enforcement of the Acts. There need be no fear of that, for the power which they asked should be given to the Court was merely a discretionary power to grant or refuse expenses to either party as to the Court might seem just, having regard to the special circumstances of each case. Although power to give expenses existed in England, he had never heard that the enforcement

of the Acts had been hampered thereby. On this point the law of Scotland should be made the same as that of England. The last reform he advocated was the giving of power to the Board of Agriculture to issue from time to time such Orders and Regulations as they might think fit to ensure that the law should be administered in as equitable a manner as possible, having regard to the conflicting interests involved. Hitherto, although they themselves made the standard, their circulars and other publications had been treated as of no force and effect, and refused as evidence in the Courts. Accordingly, all future Orders and Regulations should have the force of law. If this were done these would act as a powerful check against the indiscriminate and oppressive administration of the law, of which they have had more than enough in the past. His view was that a strong and persistent agitation for a reconsideration of the whole question of the standard in the light and on the lines of the experimental and other data which had accumulated since 1900 should be embarked upon by the Scottish Farmers' Union, in combination with the English Union. Fortunately, the controversy was one that could be conducted, not in hostility and recrimination with adverse interests, but on the plane of friendly co-operation in the endeavour to find, if not an ideal, at all events a final solution until the milk supply of the nation was organised, as it certainly would be some day—perhaps sooner than some of them expected—on lines totally different from the present.—*The Scottish Farmer.*

Basic Slag and Rock Phosphates.—For some considerable time farmers and agriculturists generally have been experiencing considerable difficulty in securing adequate supplies of such staple phosphatic manures as superphosphate and high grade basic slag. The available supplies of superphosphate and high grade basic slag are not likely materially to increase so long as hostilities continue, and it is only natural, therefore, that attention should be directed to other sources of phosphates which up to the present time have been little utilised.

Two very large sources of such phosphates are available to meet the deficiency. These are open-hearth basic slag, or fluorspar slag, and rock phosphates. Of the two, basic slag produced in the manufacture of steel by the basic open-hearth process is at present by far the more important, as no over-sea transport is necessary, there being abundant supplies in this country.

Basic open-hearth steel has been manufactured in this country for many years, but the slag which is produced as a by-product has

been condemned as of no agricultural value, because it did not conform to the standard set up by the citric acid test. The chemist uses the citric acid test to determine the amount of the phosphate in the slag which is soluble and, therefore, presumably available to the plant, and he does so by submitting 5 grams of the slag to half-an-hour's shaking with 500c.c. of 2 per cent. citric acid. The phosphate which is not soluble in this solution is assumed to have little or no value to the plant. The phosphates in open-hearth fluorspar basic slag and rock phosphates have a very low solubilty in the standard citric acid solution, and it has been held that these phosphates have practically no direct agricultural value. The use of rock phosphates in this country has, therefore, been confined to the manufacture of superphosphate, whilst open-hearth basic slag has been chiefly utilised for road-making purposes.

This is all the more unfortunate as no reliable evidence supporting the value of the citric acid test exists in this country. Its efficiency as a laboratory operation has been questioned. It has been shown that the test as practised does not give even an approximate idea of the solubility of open-hearth basic slag and rock phosphates. In many cases the error is over 100 per cent.

It is clear, therefore, that the value of these phosphates must not be judged by indications obtained from an empirical test, but upon the results of field experiments conducted on a farming scale. The necessity for a large number of experiments may be judged in the light of Professor Gilchrist's estimate that there are 750,000 tons of open-hearth basic slag annually available in this country. A very large proportion of the slag has a phosphate content of from 18 to 27 per cent. of phosphate.

With the object of determining the value of open-hearth basic slag and rock phosphates three series of experiments were laid down in Essex by the East Anglian Institute of Agriculture. The experiments were started in the autumn of 1915 on meadow hay land, Three types of soil were selected : (1) Boulder clay, (2) London clay. and (3) Chalky boulder clay. The plots were a quarter of an acre in area, and each of the plots received the same amount of total phosphate. The dressing was equivalent to about 10 cwt. per acre of a high grade basic slag containing 42 per cent. of phosphate. The hay crops of 1916 and 1917 were weighed.

Only the one dressing of slag has been given and no other manures have been applied. The experiments are still in progress,* and it is intended to let them run for at least three more years without

* See Board of Agricultural Journal, January, 1918.

any further dressing. Meantime, it can be said that the rock phosphate applied to Plot 2 and the open-hearth basic slag applied to Plot 4 have given exceedingly profitable results, and that up to the present the generally accepted superiority of the high citric soluble slag has not been demonstrated.

The summarised results are here given :—

Plot.	Percentage of total phosphate soluble in Citric Acid.	Average weight hay for 2 years on the 3 centres. Cwts. per acre.
1. High grade basic slag, containing 38·9 per cent. phosphate	92	.. 39·8
2. Gafsa Rock Phosphate, containing 57·2 per cent. phosphate ..	38	.. 37·3
3. No manure	—	.. 29·1
4. Open-hearth or fluorspar basic slag, containing 27·0 per cent phosphate	45	.. 41·5
5. High citric soluble basic slag, containing 25·1 per cent. phosphate	93	.. 38·2
6. High citric soluble basic slag containing 21·1 per cent. phosphate ..	82	.. 40·0

The open-hearth basic slag used had a citric solubility of 45 per cent., compared with a solubility of 90 per cent. for ordinary high soluble basic slag. Nevertheless, it must be pointed out that open-hearth basic slags of as low a solubility as 20 per cent. are likely to be placed on the market. At the time the field experiments given above were laid down it was not found possible to obtain an open-hearth basic slag of such low solubility. Since then, how ever, one of these slags has been secured and nine further series of field experiments have been started. But it will not be possible until next hay harvest to state definitely the value of such a low soluble slag.

The supply of high soluble slag—high and low grade—is not sufficient to meet the demand, and the Ministry of Munitions has, therefore, arranged for the grinding up of large quantities of open-hearth basic slag. At present about 1,200 tons are being ground daily, and the best method of utilising this slag becomes a pressing and important problem.

At the present time a much greater production of cereal crops is an object of urgent necessity, and one which is being achieved by bringing under cultivation large acreas of pasture land. It is

obvious, if we are in the future to maintain our head of live stock at the former high level, that our remaining pasture land should be made to produce much more than in the past. There are hundreds of thousands of acres of poor pasture on heavy clay soil in this country. If agricultural science has demonstrated one thing more than another it is that by the judicious application of basic slag the returns from our grass land can be more than doubled. The writer would therefore suggest that as far as possible this new open-hearth basic slag should be utilised for improving the poor pasture and meadow hay land, and the normal high citric soluble slag reserved for cereal crops. This course is suggested for two reasons:—(1) Because it has been shown, both in Essex and elsewhere, that open-hearth basic slags are capable of giving excellent and profitable results on poor, heavy clay pasture land; (2) Because, as they have only recently been placed on the agricultural market, no reliable data are as yet forthcoming as to their effect on cereal crops.

To obtain the best results from open-hearth basic slag or from rock phosphates two conditions are necessary:—

(1) *Fine Grinding.*—This point cannot be too often emphasised, and much more importance should be attached to it than at present. It is usual to be content with a "fineness of grinding of 80 per cent." that is to say, such a fineness that 80 per cent. of the slag will pass a sieve with 10,000 holes to the square inch. A greater fineness of grinding is desirable and can be obtained. Portland cement is ground so that 95 per cent. passes a sieve with 32,400 holes to the square inch, and there is no reason why that standard should not be obtained for basic slag.

(2) *Early Application.*—It is quite possible that open-hearth basic slag and rock phosphates may be slower in their action than the normal high soluble basic slags. To obviate this possible disadvantage early application is very desirable. Whenever possible open-hearth basic slag should be applied in the early autumn. If it is applied in the late winter or early spring it may show little return during the year of application. None of its value would be lost, however, and the full benefit would be derived in succeeding years.

The rate of application is an important point, particularly when the slag is being applied with the object of improving poor meadow land. A heavy dressing is desirable and should, whenever possible, be given. The dressing which has been found most economical in Northumberland and Durham, in Essex and elsewhere is one which is equivalent to 200lb. of phosphoric acid per acre. In the following

table the quantity equivalent to 200lb. of phosphoric acid per acre for various quality slags is given :—

Quality of slag.	Dressing equivalent to 200 lbs. of phosphoric acid p. acre, cwts. per acre.
Total phosphate 40%	9·8
" " 30%	13·1
" " 28%	14·0
" " 26%	15·1
" " 24%	16·3
" " 22%	17·8
" " 20%	19·6
" " 18%	21·8

Such applications will effect marked improvement and will be quite sufficient for five or six years. At the end of this time the improvement in the pasture may be maintained by applying half the above dressing every third year, or the whole dressing every sixth year.

In the past considerable jealousy has existed between the firms selling high citric soluble slag and those desirous of selling low citric soluble slags. It has been urged by the former that all phosphates which are not soluble in citric acid are worthless, and their propaganda has had a certain amount of success. On the other hand, their commercial rivals have insisted on obtaining as high a price per unit of phosphate for open-hearth basic slag as for high citric soluble slag, and it must be admitted have used every effort to disguise the fact that there is any chemical difference between the two varieties of slag. Both points of view are wrong. Open-hearth basic slag should come on the market under a new name, such as "fluorspar slag," and at a rate cheap enough to tempt the farmer to buy. As its undoubted merits became recognised, the law of supply and demand will quickly give open-hearth or fluorspar basic slag and rock phosphates their fair place in the manure price lists.—G. Scott Robertson in *Farmer and Stockbreeder Year Book.*

Cheap Fowls a Cause of Failure.—When everyone who aims at becoming a successful poultry-keeper, no matter whether of twelve fowls or of as many hundreds, realises that the production of eggs is the foundation of success and profit, something will have been accomplished, because there is at the present day a very unfortunate belief that unless fowls are cheap to purchase it is not possible to make them pay. This is a complete fallacy, and the sooner such

unwise theory is discarded the better for the poultry-keeping prospects of the future.

Many, we might say most, cheap birds are dear at any price, even if their purchasers could possess them for next to nothing they would still make a very bad bargain as such birds are excellent machines for the consumption of food to no purpose.

There are many thousands of sad and disappointed poultry-keepers in England who would confirm this statement. For a long time they have tried to make their fowls pay, but for want of proper strains the birds have merely consumed food and given back only sufficient eggs to reproduce their unprofitable selves.

This is not an overdrawn picture. It does not over emphasise the unenviable position of those who have tried to make fowls pay and failed, not for want of proper care and attention, but because the birds could not lay, no matter how well they were tended.

To make fowls pay—whether the few birds kept in the confined run of the cottage or town worker; or the more favoured fowl of the better classes kept to supply the household with new-laid eggs daily, who by their pleasing appearance, create an interest also for themselves; or the fowls kept on a farm—it is absolutely necessary that they should be from good laying strains.

Without eggs nothing can be done.

Unfortunately, prospective poultry-keepers have become imbued with the idea that the market value of a fowl having generally been from 3s. to 4s., it is not necessary to give more to purchase birds for laying and to breed from. This belief is the foundation for much disappointment, because in nearly every case birds which can be bought for this price are just those which should be avoided by all who wish to make their fowls pay.

The prices obtained for new-laid eggs prove that those who have fowls which they know will produce four eggs per week—each of which will sell at twopence (or more)—will not sacrifice such birds for about 3s. each, as the eggs they would lay would bring in more than that in two months, and the birds would still remain for future profit.

Pure-bred birds from thoroughly reliable laying strains, even if they cost from 8s. to 10s. each, will show a better return for food consumed than those for which the initial outlay of 3s. has been paid.

Profitable fowls give continued pleasure during the time they are kept, on account of their satisfactory yield of eggs, and when they are replaced by others they are not a total loss on account of being in good condition for boiling.

When fowls are wanted only for egg-production money is well-

invested in a few really good-laying pullets, and there are many ardent lovers of fowls whose poultry-keeping experiences do not extend beyond the care of a few good layers. Those who have been unfortunate enough to buy fowls for laying, just because they have appeared cheap, will soon realise that they are spending money unwisely, and should adopt our suggestion and go in for birds the initial cost of which is high, but from which paying results are obtainable.

In purchasing a pen of pure birds for breeding purposes, it is not always satisfactory to rely on the statement that birds are of a certain breeder's strain, for there are many unscrupulous people who advertise fowls and state that they are from a well-known strain, when the birds have been reared from nondescript stock. The result of the season's breeding reveals to the owner that the progeny from his pens have no uniformity in shape or colouring, and the chickens instead of being a source of delight are a great disappointment.

It is much better for those who wish to breed good layers, and birds which possess the characteristics of their variety, to buy birds from breeders who have the interests of their customers at heart, as well as their own reputation at stake. The results are so much better all round that the extra money invested is repaid many times over. In the first place they get a great many more eggs from the pen of birds on account of their being good layers; this means that a much larger number of chickens are hatched out than would be possible from a pen of bad layers, and every bird is turned to profitable account.

Then, above all, there is the important question of the vitality and stamina possessed by those birds which are bred for sale by reputable poultry-breeders; for vitality and stamina are absolutely necessary if the birds are to be bred from.

Serious losses are sustained by the unsuspecting poultry-keepers who purchase fowls and chicks promiscuously. They have difficulty in getting eggs at all, and when they do they find it impossible to rear the chickens on account of their general debility. In spite of the use of some of the best foods on the market, the fate of many frail chickens is sealed by reason of their inherited weakness, due to the custom of mating together related birds, or of not regarding as of sufficient importance the health of the stock.—*Mark Lane Express.*

The Farmer's Library.

NOTES AND REVIEWS OF NEW BOOKS.

1.—*The Nutrition of Farm Animals.* By H. P. ARMSBY. London: Macmillan & Co., Ltd.

The appearance of this book is timely, for there never has been a period when it was of greater importance that farm stock should be fed with the maximum of skill and the minimum of food. In the past there has been great extravagance, largely due to want of knowledge. No man living has the right to speak on the feeding of stock with greater authority than the veteran expert of the United States Department of Agriculture, Dr. Armsby. His "Manual of Cattle Feeding," written in 1882, we have always treasured. Since then much new knowledge has been acquired and Dr. Armsby has studied this critically and utilised it in the production of this work, which we consider the most important contribution to agricultural literature made during the past year. The author believes :—

> "That greater emphasis than they sometimes receive may wisely be laid upon the chemical and physiological laws which underlie the practice of feeding, both on account of their intrinsic importance and because the subject may thus be made a real collegiate discipline which shall contribute to the training as well as to the information of the student."

Hence the aim of the author in this volume is :—

> "to discuss the fundamental principles upon which successful stock feeding is consciously or unconsciously based in the firm persuasion of the truth so pithily expressed almost half a century ago by the father of agricultural science in the United States, Professor S. W. Johnson, that, other qualifications being equal, the more advanced and complete the theory of which the farmer is the master the more successful must be his farming. The more he knows the more he can do. The more deeply, comprehensively, and clearly he can think, the more economically and advantageously can he work."

Thus the author comes back to enforcing what has been from its inception the motto of the Bath and West Society—" Work and Learn." In the whole range of the work of the farmer nothing is more important than the economical feeding of live stock. In this country which is essentially a stock raising country, it should be the first consideration of every farmer, and however desirable it may be to increase our wheat supply if this is done at the sacrifice of stock rearing it will ultimately spell ruin to British agriculture.

Hence the importance of a work like this of Dr. Armsby. What he sets out to do in this book is best described in his own words :—

> " The animal body is essentially a transformer of energy—a mechanism for the conversion of the chemical energy of its feed into motion energy while more or less incidentally a reserve of energy—containing material may be stored up which can be utilised for human food. It is this capacity of the animal body to store up in itself or in its secretions a part of the matter and energy of the feed it consumes which gives the animal its economic significance as a conserver of the food supply. Its value in this respect depends upon the proportion of its feed which it is able thus to set aside—*i.e.*, upon the balance between the income and outgo of matter and of energy—and it is from this point of view that the present volume undertakes to present the nutrition of farm animals. From this standpoint, the subject naturally falls into four principal divisions.
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> " First. Since nutrition involves chemical changes by which feed substances are converted into body substances, there is required some knowledge of the chemical compounds concerned and of their occurrence and proportions in plants and animals.
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> " Second. The conversion of feed substances into body substances is a function of the living organism and it becomes necessary, therefore, to learn something of the processes by which the body effects these changes or, in other words, to study the physiology of nutrition.
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> " Third. In order to apply the principles of the chemistry and physiology of nutrition to the practical problems arising in the feeding of farm animals it is requisite to determine quantitatively the amounts of matter and of energy which are required by different species of animals for their support and for the production of meat, milk, or work.
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> " Fourthly, to supply the feed requirements as thus ascertained in the most economical manner demands a knowledge of

the available food resources, both as to the nature and quantity of nutriment which they contain, and as to the proportion of this nutriment which can be utilized by the body."

The book is, therefore, divided into four parts, each treating of one of the four subjects above mentioned.

It would be impossible and it is certainly unnecessary to follow the author through the 700 closely packed pages of this remarkable book, which will, we think, be the standard work on the feeding of stock for many years to come. But there are some points of special importance at the present day which we may draw attention to and throw some light upon from the author's work.

The food problem in England has brought into existence a vast amount of ephemeral literature regarding problems of food and feeding. It is evident that much of this has been written by men who had not sufficiently studied the subject And this appears to be true of much that has been written in other countries. The greatest fallacy of all, and curiously enough the one which has been made most of, has been an attempt to estimate foods by what is known as their calorific or heat-producing power.

In applying this standard to farm stock those animals have been condemned which did not obtain and store up the greatest amount of calorific power, most generally termed "calories," from their food. If we drive this argument to its logical conclusion, and can prove that calories are lost by the conversion of grass into beef or mutton, the rational conclusion is that men should once more, like Nebuchadnezzar, eat the grass himself, which is absurd, as old Euclid used to put it. But Euclid is now out of fashion, and many things, which to a clear reason are absurd, are not now seen by all to be so.

The true aspect of this question is best stated in the following sentences from the author's introduction :—

> "It is a well-recognised fact that only the smaller portion of the solar energy or of the proteins which are stored up in the farmer's crops is directly available for man's use. Even in distinctively food crops, such as wheat, for example, more than two-thirds of the energy which they contain may be unavailable for human nutrition, while the grasses and legumes, so important in all systems of agriculture, are of no direct value as food for man. The essential function of the animal in a permanent system of agriculture is the conversion of as large a proportion as possible of these inedible products into forms whose matter and energy can be utilised by the human body."

"For the conversion of the by-products of the farm and factory into human food, there is as yet no suggestion of an agency which can take the place of the animal body."

"With the growth of the non-agricultural population it is increasingly important that this function of conserving the food supply through the utilization of inedible soil products shall be performed with a maximum of efficiency."

How much this country has lost of possible food by not realising the facts so well stated above it is impossible to estimate. Our duty was evident; to conserve our live stock, to increase it in the direction in which it would afford the maximum of food for the people, and then to see how far it was possible to increase the wheat area.

When studying this book one feels that the whole subject of nutrition has of late years become too mathematical, one might even say mechanical. There seems to have been far too much stress laid upon the calorific or heat-producing power of food and upon attempts to estimate its value as one would the value of oil in an oil engine, simply by the amount of heat or work it could perform. However similar in some respects the animal body is to a machine in others it is quite unlike. Two engines of the same type and size might possibly give identical results with like amounts of fuel, but no two cows, horses or pigs, much less men, would be likely to do this. There come into play with everything living two great factors which do not affect machines—individuality and nervous temperament.

The trend of modern science is to estimate all foods by what is termed their heat or calorific power. The author describes it as follows:—

"In practice heat is the form of energy which generally lends itself most readily to exact determination, and, since other forms of energy are easily converted into heat, units of heat are extensively employed in the study of energy. The most common unit for this purpose is the *calorie* which is the quantity of heat required to raise the temperature of one gram of water one degree centigrade."

"This is known as the small or gram calorie (cal.). Where larger quantities of heat are to be measured the large or kilogram calorie (Cal.), equal to 1,000 small calories, is employed, while for still larger quantities the *Therm*, equal to 1,000 large calories, may be used."

We are of opinion that this method of judging food by calories has led to more serious trouble than is as yet fully realised, though there are signs that this fact is gradually dawning upon a few.

Food, to be of maximum utility, must contain a certain amount and right proportion of Albumins (*i.e.*, nitrogenous compounds), of Fat, of Carbohydrates, and also of mineral matter, which latter is far too frequently overlooked, while its function and influence have not been properly studied. But in addition these substances must not only be present in the food but available to the animal, in other words what we call digestible.

With the advance of science it also becomes evident that substances called Vitamines, present in minute quantities and hitherto overlooked, play a part in importance altogether out of proportion to their quantity. In fact, the more we know the less we seem to know.

The author draws attention even to these bodies, which shows how thoroughly up to date this treatise is.

2.—*The Principles of Rational Education.* By C. A. Mercier, M.D. London: The Mental Culture Enterprise. 2s. 9d.

At a time like the present when the subject of education is receiving so much attention, this book will be welcomed by all those who are anxious that the nation should move upon right lines.

Dr. Mercier is an original thinker and a powerful writer. Those who have made special study of the books on education which are so numerous, will most probably agree with a reviewer, writing, if we remember rightly, in the *Times Literary Supplement,* who considers the work under review the best work written since the world-famous book on Education by the greatest British philosopher of the nineteenth century, Herbert Spencer. The book under notice is largely controversial, inasmuch as it combats what it regards as that fetish of English education a "classical" training, and the blind worship of Greek and Latin.

Fortunately, the author is not merely controversial. If he pulls down one idol he puts another in its place, and he supports his choice with powerful arguments, and inspiring suggestions.

He asks the question, What should be the purpose of education? And his answer is "Education should be preparation for life."

"Its purpose is to fit the child for the life he is to live when he shall be no longer a child."

Education is an art, and as the author points out :—

> "Art is the shaping of material to fit the purpose in view; and, therefore, in the pursuit of every art there are three things to consider: first the material on which we are to work; second, the purpose we have in view; and third, the means and methods by which the material is to be treated in order to achieve the purpose. The husbandman is to consider his land, to learn its qualities and capabilities: he is to consider the crops that he wishes to raise, their natures and amounts; and he is to consider the means and methods that he is to employ upon his land so that he may raise the crops he wants."

Foremost among educational methods he places "learning by doing," and his views so strikingly illustrate what we believe to be the best method of educating children in rural districts that we quote him at some length :—

> "Physiography should be learned by every child, but it should be learned, not by the cart-before-the-horse method by which everything is taught in schools; not by beginning with the globe and working down through the continent and the country to the county and the village; not by repeating the words that are read in books, which is no learning and leads to no knowledge; but by a method precisely the reverse. It should begin with the examination of the playground, and proceed to examination of the surrounding town or village, of the fields, the ditches, the streams, the mounds, hills, dales, and valleys; and when these have been traversed and examined, when plans can be read and made of them, then maps will begin to have a meaning, and these may be brought into use. It is no great mental feat for a child to discover for itself that water runs downhill, that one ditch leads to another, that the junction of two ditches makes a bigger stream; but by these trifling observations the formation of rivers may be understood. Any child can see that water lies in the lowest level, and that if there is no outlet, the ditch will form a pond; and thus it may understand the lake. Nor is it enough, nor would it be true, to let the child grow up in the belief that the landscape he sees, the course of the streams, the relief of the land, have always been such as they are, and will remain unchanged. He is not to be told, but is to be led to find out for himself, that the hills and ditches and streams after rain are muddy.

He is to be led to see that the mud comes from somewhere and goes somewhere else, and so to reason for himself that if this goes on indefinitely, the hills will waste away, and the ponds will be filled up. He is to be brought to remind himself that the ponds do get filled up, for they have to be periodically cleaned out; and thus he gradually becomes familiarised with the strange notion that nothing remains the same. Everything is changing. Change is the law of the universe. Tell him this, and the words are empty. They mean nothing to him. Lead him to find it out for himself, and not only does the knowledge grow to be part of his nature, not only is the process of discovery in itself delightful, but all the while he is educating his faculties, developing his powers of observation and of thought, building up both mind and nervous process, and preparing the way for fresh discoveries. Thus geography, physiography, and geology become as closely connected in his mind as they are in nature, and every fresh discovery in one leads to more knowledge of the others. The knowledge of living things is to be acquired in the same way; not out of books, but by actual observation of the things themselves, and to this end there is nothing so helpful as the cultivation of a plot of ground. The cultivation of a rod of ground, or even of a yard of ground, is an education in itself, and a means of education that may and should be supplemented, but that cannot be bettered. In this, as in everything else, the child is to be guided and led to find out for himself. He is not to be told. That is the lazy and useless method, lazy and useless alike for the child and his teacher. It is a sterile method, and leads to nothing. After what has been said it is unnecessary to go into detail, but consider how much a child learns of the nature of the world in which he lives, and how much he educates, develops, and strengthens his faculties, both of mind and body, by tilling a patch of ground under intelligent guidance—under guidance that keeps him doing and doing, thinking and thinking, all the time. The doing enables him not only to do better, but also to think better, the thinking leads not only to better thinking, but to better doing. He is not to be told. He is not to be warned of his mistakes. Let him make mistakes. It is by making mistakes, and recognizing mistakes that he will best learn not to make more."

"In the operations of digging, trenching, hoeing, raking, the child is exercising and cultivating his bodily faculties. In weeding he is exercising observation and discrimination as well.

In setting out his ground, in selecting the site and proportion of ground for this and that kind of seed, he is exercising judgment and foresight. If his crops succeed, he has the unsurpassable gratification of success, if they fail he is to find out the cause of their failure ; and for this, observation, reasoning, and it may be experiment, are necessary. In the course of his gardening he learns the morphology and physiology of vegetable life, and along this path he may be allured, for it is most interesting to most children. He learns the astonishing and enthralling process of organic growth and development. He sees before his eyes the seedlings grow into mature plants, and produce flower and seed. He learns the inter-dependence and inter-relations of animal and vegetable life. He learns how the dead animal fertilizes the soil for the growth of the vegetable, and the vegetable in turn serves for food for the animal. Properly guided, he learns how many scores of seeds lie dormant in every square foot of ground, and of how many different kinds they consist, how some are crowded out, stifled, and die, while others succeed, flourish, and maintain their vigour. He learns many of the innumerable devices by which different plants cunningly contrive in different ways to secure their share of light, of air, of space, of food, to repel or avoid, or hide from the animals that would consume them, to attract the insects necessary for their fertilization, to guard against drought, to protect their pollen, to disperse their seeds, and scores of other particulars. Besides all this he becomes conscious of wants. He wants a tool that will do this, or an appliance that will do that. He wants a hook that he can insinuate between his plants to hook out the weeds ; he wants a net that will protect his seeds from the birds ; and the school-master who knows his business will not permit him to buy them. He must design them, and he must make them himself. But he does not know how ? He has not the skill ? Then he has a strong motive to learn how ; he has a strong motive to acquire the skill. Let him try, and if he does not succeed let him have the minimum of assistance and guidance that is necessary to enable him to succeed. Some of his crops will fail. Some of his plants will die. Some of them may become diseased. Here is more material for thought, more opportunity for observation, for experiment, for tracing the relation of cause and effect, for comparison and discrimination of conditions. Why do some fail, some die, some become diseased, and others flourish ? It is for the child to find out. He is not to be told. He is not to be shown. A

hint, a suggestion, may be given. A question may be asked. He may have his face turned in the right direction and his feet placed upon the path; but he is to follow the path by his own efforts, on his own feet, to wherever it may lead him."

On some points we do not agree with the author, but they are points which do not materially affect his main proposition. Even when we disagreed with him we read on with interest, which at other times became absorbing. His very style leads to rapid reading for he seems to possess some of that art in which De Quincy was master, of writing in such a style that the reader went slowly or quickly as the author desired. To a certain extent this detracts from the value of the book, for what we read quickly we are likely to forget quickly. But this book needs to be read and re-read. If the author is right then it is the duty of every parent to see that his children are educated upon these lines. Moreover, it is the duty of every rural authority to see that such education as is given shall fit children for a rural life, and not merely to make them drudges in the towns. Lastly, it is the duty of the State to put a stop to false ideals in education, for the future of this nation in the coming world-struggle will depend mainly on that. The real ideal of all education is the development of character. How far Dr. Mercier's system tends to that ideal we must leave readers of his book to judge for themselves, and we feel sure they will not regret the study they bestow upon it.

3.—*The Marketing of Farm Products.* By L. D. H. WELD, Ph.D. London: Macmillan & Co.

The title of this book really gives no idea of its wide scope and intrinsic merit. Its aim is to set forth the fundamental principles of market distribution as applied to the marketing of agricultural products. It begins by pointing out the place that marketing occupies in the general field of economics, then explains the general methods and organization of marketing, and the functions of wholesale dealers. After describing the factors affecting the cost of marketing, a number of special problems, including transportation, future trading, co-operative marketing, etc., are dealt with.

It is a remarkable fact that very little scientific or systematic study has been given to the problems of marketing, either in this country or abroad. This book is written by an American and

deals with the problems mainly as they arise there. But the systems of marketing have been more or less the same throughout the whole world. Probably no country ought to have studied them more carefully than our own. In this, however, as in so many other matters, things have been allowed to drift under the impression that they would right themselves. Now the war has shown us that we were mistaken and that our methods of marketing, which sufficed in a time of peace and plenty, were quite inadequate for other times. Moreover, the present conditions have brought out strongly what the author appears to have seen already in America, " the astonishing misconceptions on the part of the general public " regarding the questions of marketing.

The word " profiteering " is glibly used by those who are discontented, without their having any knowledge or judgment to justify their use of the term.

When prices rise above what they have been, people immediately jump to the conclusion that someone is trying to make an illegitimate profit. Evidently they judge human nature by their own standard. It is what they would do if they had the chance, so probably others are doing it. As the author says :—

> " To make the necessary investigations of market practices, to classify the data collected, and to draw sound conclusions as to fundamental principles is not so easy as is commonly thought. Too many speakers and writers are making glaring statements without a sufficient foundation of knowledge, and without having a broad enough point of view to include the interests of all people concerned with the marketing process. To attack the problem rationally—it is first necessary to understand the place that marketing occupies in our general economic system."

This leads the author to his first and main proposition, " Marketing is a part of production," which will need careful attention. Both the public and professional economists usually divide the subject into production, distribution, and consumption, and speak of these as if they were three separate and distinct divisions. But they are not. Production is the creation of utilities. Any process that makes a thing more useful is a productive process. Thus " by transporting it from one place where it is less needed to another place where it is more needed, or by storing it from one season of the year when it is less needed until another season when it is more needed," we add to the usefulness of the commodities, and these become a part of production. To put it in another way. If pro-

duction may be defined as the creation of utilities, so utilities may be divided into materials, time, place and possession.

Agricultural products fall into the first class. Time-utilities are created by holding or storing commodities until they are needed. Thus the storage of eggs and butter from times of surplus production to times of deficient production results in an addition of usefulness, or time-utility. Place-utilities are created by carrying commodities from one place to another. The wheat of the American Northwest would be of little value if it could not be transported from that area of surplus production to the great centres of consumption. Finally, possession-utilities are created by the exchange of goods from one person to others.

Thus it is apparent that marketing deals primarily with the creation of time, place and possession utilities.

The author having laid down these fundamental principles, says :

> "Agricultural economists have concerned themselves primarily with the raising of crops, farm management, feeding of animals, etc., and not to any great extent with the marketing of the products. The marketing process has never been subjected to careful scientific analysis, and yet the marketing part of production is extremely important."
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> "Now that nation-wide interest has been aroused in the subject, there has been no authentic source to which one might turn for definite and impartial knowledge. As a result, many mistaken notions have been spread abroad, and the general public believes that there is something radically wrong with the whole marketing system, and that it is fundamentally defective. . . . . So many misleading and absurd statements have been allowed to pass unchallenged by men who ought to be in a position to lead and influence public opinion, that it will take some time to bring the public into a sane frame of mind with regard to this vital part of our economic system."

When we begin to study the different ways by which a farmer may market his products we begin to realise how large and complicated this subject of marketing is. For example, the author enumerates five different ways of marketing by the producer at country points as follows :—

(1) By direct sale to consumers—
- (*a*) By going direct to residences.
- (*b*) Through public markets.
- (*c*) By parcel post.
- (*d*) To local manufacturers.

(2) By selling to local stores.

(3) By shipping direct to dealers in large towns.

(4) By selling to a local buyer.

(5) By shipping through a co-operative association.

These methods are dealt with in detail. But they are not the only methods of disposal. The farmer may sell to the dealer in a distant city. This leads to a consideration of the methods of sale, and then to the study of the wholesale produce trade, in connection with which cold storage as a factor in marketing receives attention.

An interesting study of the cost of marketing will probably prove one of the most attractive features of this valuable book.

As might be expected the place, functions and influence of the middleman receive considerable attention and have been dealt with to our thinking in a scientific and impartial manner.

Every branch of marketing is dealt with up to the "Problems of Retailing." Finally there is a short chapter upon "weaknesses, remedies and governmental activities."

The chief object of the author has been "to describe the main features of the organisation and methods of marketing as they are. There is ample economic justification for the main features of the present marketing organization. Still there are defects, and they are not only very numerous but they are of great diversity."

Unlike so many books on economic questions this is throughout interesting reading, highly instructive, even apart from its economic value, and one which might be studied with advantage not merely by economists but by all those who are producers and distributors of agricultural products as well as by politicians interested in the food supply of the nation.

4.—*Practical Cheddar Cheese-making.* By DORA G. SAKER. St. Albans. The Campfield Press. 2s. 6d.

5.—*Practical Cheese-making.* By C. W. WALKER-TISDALE and W. E. WOODNUTT. London: Headley Bros. 4s. 6d.

It is well that at a time like the present these two very reliable guides to cheese-making should have appeared. Men can live and work on bread and cheese, they supply all the nutriment that mind and body require, the former mainly starch and the latter fat and nitrogenous food. Moreover, every particle of food in cheese is digestible while there are very few other articles of food of which this can be said.

A gallon of milk makes a pound of cheese, whether that cheese be good or bad, and it is a scandalous waste of good material to make inferior cheese. Yet much very inferior cheese has, especially of late, been put upon the market. Only the very poor buy it, mainly because they cannot afford better. But an inferior cheese is not good food, will not maintain the health of those who consume it, is often actually injurious, and at times poisonous. Hence those who from carelessness or ignorance make inferior cheese are not only wasting a valuable article of food—milk—but are responsible for much ill health among the poor. If makers would realise this surely they would take some steps to improve their methods, and they could not do better than study these books.

Both authors point out that the first essential of good cheese-making is clean milk. Without that it is quite hopeless to try and make good cheese. The most skilful maker could not do so. Given clean milk, a fair amount of experience, and a knowledge of what the cheese-maker should aim at, and there should be little difficulty in ensuring a supply of good quality cheese, the most valuable food product of this country.

Miss Saker confines herself to Cheddar Cheese—the cheese of our Empire. A good guide to its present-day manufacture was greatly needed, and she supplies that need well. Cheese-making only a quarter of a century ago was an industry governed almost entirely by rule of thumb. To-day it is a scientific industry to those who appreciate it thoroughly. Temperature which was determined by the sense of feeling is now controlled by the thermometer. Acidity, which was determined solely by the taste, can now be estimated exactly by the acidimeter. And lastly, the development in the milk of the bacteria producing acidity, which in the past was left mainly to chance, is now controlled by the introduction of the

proper bacteria into the milk in the form of pure cultures, *i.e.*, cultures free from undesirable bacteria—known as Starters.

In spite of all these undoubted advantages, it is well known that modern makers can seldom turn out cheese equal to the best made before these appliances were known. Hence the factor of skill still remains pre-eminent.

What these modern methods have done has been to improve greatly the general make of the country, thus ensuring higher prices and a greater profit on cheese-making generally. But for the production of the best the necessity of study as well as of practice is still imperative.

There is not a detail of the practice of Cheddar cheese-making which Miss Saker does not clearly explain, while throughout her admirable guide she bears in mind, and points out to those engaged in the industry, the utility and application of that knowledge of principles which we term Science.

This scientific side of cheese-making is entered into more fully by the authors of the second book now under notice.

The main portion of their book is devoted to the general principles which underlie the manufacture of all varieties of cheese, and the remainder to a description of the special methods adopted in the manufacture of Cheddar, Cheshire, Leicester, Derby, Caerphilly, and Wensleydale cheese.

The authors point out, as did Miss Saker, the paramount importance of clean milk. They say "the first essential point in the manufacture of prime quality cheese is to utilise only pure, clean, whole milk of good quality. It is imperative that the milk be obtained in a cleanly manner from healthy cows."

The manufacture of good cheese depends therefore upon more than the knowledge and skill of the cheese-maker. The farmer has his duty to perform in seeing that the milk is of good quality, from healthy cows. This can only be ensured by proper feeding and management. The milkers have their duty to perform in taking care that they themselves, especially their hands, are clean, that the milking is done in a clean place in a cleanly manner and into clean vessels. It is not until the milk comes into the dairy that the cheese-maker's duty commences, and if the milk then is not in a fit condition no amount of skill can make good cheese out of it. The attempt is disheartening, and everyone suffers. Given good milk to work with, those who make cheese should no longer fail for want of knowledge for these books provide all that is needed and are published at prices which are easily within the reach of every cheese-maker or student of cheese-making.

Even when these works have been studied, and when by experience makers have learned the art of making good cheese, or even the very best cheese, they will still feel that there is yet something further to learn. Much as we know there is much which is still a mystery. If a large volume of milk were divided among ten skilled makers it would be possible for that milk to produce ten varieties of cheese, each distinct in appearance, flavour and other characteristics. Nothing would have been added to the milk to account for these variations. They would be due entirely to natural changes occurring in the products after they had left the hands of their makers. All that these makers would have done would have been to produce the conditions favourable to those natural changes. And what these natural changes are we do not know. Much as the science and practice of cheese-making has advanced of late years, we still have much to learn. What we do know is well stated in these books.

There is one error in the second book which calls for notice. The paragraph is headed "Why the Lactometer alone is not reliable." And further on we read, "The unreliability of the lactometer lies in the fact that after extracting fat from milk and making it heavier, the judicious application of water to the milk will render the specific gravity normal." We would point out that the lactometer, if accurate, is always reliable. It tells one what it professes to tell—the specific gravity. It is the user who is not reliable if from that exact figure he jumps to a conclusion not justified. What the authors mean is that it is not possible to judge of the quality of milk from the gravity alone.

Incidentally these books raise many points which are of interest to those who are not cheese-makers. Thus Miss Saker draws attention to the want of a standard for cheese, one of those anomalies due to the non-scientific spirit of our legislators. As she says: "There is a Government standard for milk and butter, but cheese made from skim milk, half milk or whole milk is all put upon the same market and it is left to the judgment of the dealer and consumer to distinguish between them." "A large proportion of half-milk cheese comes from abroad, it is unfair to the British producer to have to compete in an open market with second-rate produce." Other countries legislate to prevent such fraud. Why are we so often behind the most enlightened nations?

6.—*The Small Grains.* By M. A. Carleton. London: Macmillan & Co. 7s. 6d.

The cultivation of the cereals is of national importance, and as the more knowledge men possess of these crops the more likely they are to ensure success, this book has at the present day a special value. It deals mainly with wheat, oats, barley and rye, and, finally, with buckwheat and rice though these two only cover some 50 of the 600 and more pages devoted to the subject. The portion devoted to wheat, oats and barley will naturally attract most attention, and the way in which the author has treated them is novel and interesting.

Having briefly described the form, structure and growth of the cereals from a botanical point of view, each of the grains is described fully in a separate chapter. The few brief historical notes are interesting, and one can scarcely realise that in China a public ceremony of sowing wheat, rice, millet and soja beans was instituted by the Emperor Chin-nung 28 centuries B.C. And yet we probably still have something to learn regarding wheat.

As is well known, man's great object is to improve the cereals, and this is done either by selection or hybridization. These subjects next receive the full attention they deserve. But in spite of all man's care and trouble to improve varieties there are certain factors always at work to modify the effect. These the author has wisely combined under the head of environment. It was said by a celebrated doctor, speaking of human beings, that in his opinion "environment would knock heredity into a cocked hat." Probably many farmers have come to the same conclusion regarding crops. Certainly the influence of soil and climate, which are the two principal factors as regards plant environment, is immense. They are carefully studied by the author. The methods of cultivation adopted are described in three divisions, corresponding to the three chief types of climatic conditions under which the four cereals are cultivated in America and Canada.

In addition to the influence of environment, all crops are subject to the ravages or deteriorating influence of certain pests, to wit weeds, insects and fungi. Whence they come, why they come, and why they so constantly vary in nature and intensity, are problems which have yet to be solved, so also have the questions of prevention and cure. It is as essential that the farmer should study these problems as that he should learn how best to cultivate the cereals. The author points out what is known about the chief pests, as also what has been done to overcome them. Finally there is a short chapter on the uses of cereals.

The book, though primarily intended for students, cannot fail to prove of value to any farmer engaged in the cultivation of cereals and anxious to obtain the most recent information. In some portions of the work its readers are expected to have an amount of botanical knowledge not always possessed by farmers, and a slight development of the first chapter so as to deal with structure and the technical names given to various parts of the plant would enhance the value of a future edition. As it is, the book is a valuable summary of our knowledge of the small cereal grains.

When one considers the great length of time during which these small grains have been cultivated one wonders why in the past all that can be known about them has not been discovered. That it has not proves beyond a doubt that no amount of practical experience is sufficient to promote our knowledge. Something more is required, and that we term Science. Not necessarily those only who are termed scientific men are possessed of the scientific spirit. Often it reveals itself in those who would not claim to be scientific, but they are so none the less, either by nature or education. Such men in agriculture have generally been considered practical men. Undoubtedly they were eminently practical, but followed scientific lines, and their progress was the outcome of keen observation, studious thought, and careful experiments. Science is the outcome of these qualities. The world cannot wait for these men to turn up by accident, once perchance in a century, so it endeavours to train men who shall be possessed of the scientific spirit and apply it for the benefit of their fellow-men. As the author, whose duty it is to organise men for such scientific work, points out, even among students it is only an occasional one who is sufficiently trained "to meet the awaiting problems of investigation." Let us hope that in the future development of agriculture in this country there may be many men so trained, for we agree with the author that "the agriculture of the future cannot be greatly improved unless the leaders themselves are placed on a firmer scientific footing."

7.—*British Insects, and How to Know Them.* By HAROLD BASTIN. London: Methuen & Co. 1s. 6d.

The readers of this Journal have from time to time had opportunity of appreciating the capabilities of the author of this book and the special faculty he possesses of writing in a clear and interesting way, for several articles relating to insects which affect agriculture have appeared from his pen in past volumes.

In this book his aim is to provide a short introduction to the study of British insects. He deals popularly with his subject, but at the same time is strictly accurate and scientific.

The term "insect" in popular parlance is applied rather indiscriminately, but it really comprises only those animal forms which are endowed with six legs. "But their six-footedness is only one among many characters which serve to separate insects from all other animals."

Everyone knows how the common shrimp, or at least its coat, appears to be made up of a series of rings or segments. The view now held by scientific authorities is that insects have descended from worm-like ancestors—creatures whose body was composed of a simple head-lobe followed by a series of nearly identical rings, each of which carried a pair of feet. In course of time the three rings behind the head-lobe have been compressed into the head and mouth-parts, the original feet of these rings having developed into the three pairs of mouth parts now found. The next three rings constitute the thorax, and the three pairs of primary feet have now developed into the three pairs of legs, often highly complicated, which characterise the class Hexapoda or Insects. The remaining segments have become converted into the abdomen. From these abdominal rings or segments, the legs have for the most part been lost, but in some cases they seem to have developed into special appendages having different functions in different insects. Such is a very general outline of the structure of a true insect.

How greatly they vary in detail the reader of this book soon begins to realize. In fact, when we consider that cockroaches, earwigs, beetles, butterflies, moths, flies, fleas, ants, bees, and wasps, together with many other forms, are all six-footed and true insects, we realise what a large and important section of animal life this book covers.

It is interesting reading, and the illustrations are numerous and excellent.

The author has evidently anticipated the one criticism which might be raised against it. He says "It is to be hoped that those

who may be induced by a perusal of the following pages to commence the study of insects will not rest content with booklore."

With a view to facilitating such study and developing the faculty of observation we would suggest that in any future edition of the work, the author might—in the case of the blue-bottle, for example—tell his readers how to examine it, what they might find, and what bearing each part had on the structure, functions and classification of insects of this type; treating the cockroach, the earwig and the moth in the same way. This would be instructive as well as interesting and would tend to inculcate the habits of observation, of recognising similarities and differences—the first steps of inductive logic.

As it stands, however, it is a valuable and interesting popular guide to insects, with many of which we are all more or less acquainted.

8.—*The Wheat Problem.* By SIR W. CROOKES. London: Longmans, Green & Co. 3s. 6d.

Twenty years ago the eminent author of this book gave an address at the British Association in which he foretold that a scarcity of wheat was within appreciable distance. Probably the speaker did not then realise how soon that time would come. But, as an able scientific man trained to acquire facts to reason from them and thus to exercise forethought and acquire foresight, he based his statement on a sure foundation and his forecast has come true. There is a shortage of wheat in the world which is for all countries, and especially for our own, a matter of serious importance. That address is here reproduced and has been extended by a further consideration of the recent developments of the wheat problem. A chapter has also been added, written by Sir Henry Rew, on "Future Wheat Supplies."

Leaving aside what has taken place in other countries let us look at home and see the state of affairs here. The author says:—

> "In 1801 there were 35½ acres of wheat per 100 of population in England and Wales, while in 1914 the acreage per 100 people was reduced to 5. The quantities grown per head of population had decreased from 8½ to 1½ bushels in the same time."

The many causes which have brought about this change are known to most agriculturists. One of these, probably the chief, was the fact that the surplus wheat of the world could be bought in England for less than that same wheat would cost to grow. But that time and those conditions have passed. The population of the world and the consumption of wheat have increased rapidly while "the general conclusion which may be drawn from these data" (as given by the author) "appears to be that the extension of the wheat-growing area is nearing its limits."

Under these circumstances "the time is ripe for an exhaustive stocktaking of the food resources of the British Empire and for the planning of a scheme for developing agriculture upon a scientific basis."

One remedy "against which no objections can be urged, although the difficulties of applying it are great, is to grow more of our own wheat."

But this does not mean merely to grow wheat upon a larger area. The author contends that the future does not depend merely upon the efforts of practical farmers to extend the area of cultivation. As a scientific man he sees that there are great scientific problems which have to be solved, thus he writes :—

> "The problem before the scientific man is to learn how to control the yield so that the average may be steadily raised. Perhaps the most disquieting feature of the whole question of the world's wheat supply is the very poor increase of yield which has been effected in the last twenty years, and it is to this fact that I wish to direct attention, as well as to the decline of wheat-growing in England."

This problem of the increase of yield per acre depends partly upon the improvement of varieties and partly upon more scientific cultivation and especially manuring. One of the main scientific questions is: where is that manure to come from? Readers will find this subject very fully discussed.

The public owe this re-issue of Sir W. Crookes' address with its valuable new matter to the action of Lord Rhondda, undertaken before he occupied the thankless post of Food Controller, and he has contributed to this valuable work a well-thought-out and instructive introduction which deserves to be read and considered by everyone interested in this great problem of our future Wheat Supply.

RURAL TEXT BOOKS.

9.—*The Principles of Plant Culture.* By E. S. GOFF, revised by J. G. MOORE and L. R. JONES.

10.—*The Principles of Agronomy.* By F. S. HARRIS and GEO. STEWART.

11.—*The Breeds of Live-stock.* By many writers, arranged by C. W. GAY.

These are all American works published in London by Messrs. Macmillan & Co., and belong to a series of which several volumes have been noticed in previous issues of the Journal.

These American text books are well printed, excellently illustrated, and written by men who are engaged in the practical work of training in agriculutral colleges. Hence the writers know just what students require, how to state the information in a way that students can assimilate, and the value of classification and the gradual progress from one stage to the next which is essential if a student is to grasp the subject he is studying.

Each author tries to make his subject complete; he does not assume that a student has already acquired certain fundamental elementary facts and principles. The student may or may not know these, but as they are essential to his subject the author states them. This means that two or more text books may in part cover the same ground as is the case with the first two under notice. There is, however, an advantage even in this. Each teacher has his own way of stating his facts and illustrating his subject, and thus a student who may think he knows these facts will often find they have a fresh significance, or are more firmly impressed on his mind as stated by one author than as stated by another.

The first of the three books under notice is one of the best guides to Plant Culture that we know of. Though intended for Agricultural or Horticultural students it is far from limited to their primary needs. In fact, it would, for those who had studied it, probably remain their main guide through many years of practical experience. The first portion is botanical and descriptive, and gives an admirable account of the structure and functions of the plant at all stages of its growth. Then follow a series of chapters showing the influence on growth of temperature, water, light, and food-supply. Animal and vegetable parasites are carefully dealt with.

The final chapters are devoted to the various methods of propagating plants. The illustrations are numerous and form most

valuable guides, while they enforce the exact meaning of the text. This may be especially said of the illustrations to the chapter on "pruning," which subject is treated with marked ability.

The book is an excellent specimen of what a practical text book should be.

Messrs. Harris and Stewart in their Principles of Agronomy go much further and appeal to a different class of student. Their book is intended for high schools and short courses in agricultural colleges. The authors, while their purpose is to teach Principles, recognise how very limited is the value of such instruction alone. They say :—

> "The teaching of agriculture is valuable only as it is made practical. It is suggested, therefore, that students work in the laboratory and field as much as possible in order to become directly familiar with soils, crops, and applications of principles instead of relying solely on what the text says about them."

The term agronomy is not yet familiar in this country. It is derived from two Greek words meaning "the use of fields" and is usually limited to the production of field crops. Thus as a rule it includes soils, crops and farm management so far as crops are concerned. Hence this book is devoted to the study of the plant generally, soils, and farm crops, while, as might be expected in a text book, only quite a small section is devoted to farm management. But the system adopted by the author, and growing rapidly in most text books, of placing at the end of each chapter references to the best available literature on the subjects treated, enables a student at least to know where to seek for further information.

One fact brought home to the students of this book is deserving daily of more attention. The modern farmer must have a knowledge of machinery.

> "He hardly does a thing without the aid of some complicated machine. The use of these various devices requires skill as well as considerable knowledge of mechanism. The farmer should also be able to repair his own machinery. If working at some distance from a machine shop, and an implement gets out of order, considerable time is lost unless the farmer is able to repair it. The expense of having someone else to do the repairing is not so important an item as the time lost in waiting for the work to be done."

Thus while no attempt is made to fully discuss the large subject of farm management, the points drawn attention to are such as

should first receive the attention of a student. While of necessity some portions of the book deal with crops and conditions purely American, in the main the work covers the same ground as would be required were it written solely for English readers. Its wider scope really adds to its value, for it would thus give a student some idea of the cultivation of crops such as are or might be raised in some of our Colonies.

The Breeds of Live Stock are admirably studied in the third volume under notice, though some of the sections are not so well treated as others, which is inevitable in a work by many authors. The full-page illustrations which are very numerous, appear to be reproductions of photographs, and are excellent, but the smaller wood-cuts in the text, while in most cases they bring out the special points required by the writer, are in some cases not so satisfactory and appear to represent animals prior to the state of perfection which is now required. This, however, is a small point, and in some respects an advantage, for it would afford the student an opportunity of discovering along what lines improvement had been made.

All the breeds of Horses, Cattle, Sheep, Goats, and Swine of any importance are considered. The classification adopted greatly helps the student, by, from the very start, indicating the especial characteristic of each group. Thus cattle are treated in four groups; Beef breeds, Dairy breeds, Dual-purpose, and lesser known cattle.

The treatment of each breed is first historical, then descriptive, its utility is considered, its distribution and its records of achievement. For some of the more important breeds the chief literature concerning it is noticed so that the student can at once proceed to obtain further and more detailed information. Unfortunately these references to literature are at times absent, and at times not so complete as might be desired. On the whole, however, the book is an excellent guide to the breeds of live stock.

12.—*British Grasses, and their employment in Agriculture.* By S. F. ARMSTRONG. Cambridge: The University Press. 6s.

This book has been written primarily for agricultural students, but at the same time the author hopes that it will be found useful to a much larger section of the community, especially to practical farmers.

The importance of the study of grasses is well pointed out by the author in the following lines:—

> "A great proportion of the existing grass land is far from being of the best quality possible. Much of it is weed covered in the sense that such plants as Buttercups, Daisies, Plantains, Hawkweeds, etc.—to say nothing of the inferior grasses—occupy the ground upon which our better forage plants would thrive. At a very moderate estimate 20 per cent. of the total area is weed covered in the above sense, which means that an area equal to at least 5 million acres is covered with comparatively worthless herbage."

Having pointed out the defects of much of the permanent grass, he considers that:—

> "Whilst certain types of soil are more adapted for permanent grass production than for any other form of cropping, it is nevertheless true that much of the land now under grass might be brought under arable cultivation with greater profit to the nation. Under a system of alternate husbandry most of the defects (to which he has drawn attention) would be corrected, and a much larger yield of food obtained from a given acreage."

But this improvement can only be brought about by those who have studied the herbage of our pastures, and the object of this book is to help this study, by enabling those who so wish to distinguish between the various kinds of grasses, to know by sight the nature of each variety, to estimate its value and to learn how best to utilise it.

Thus the book starts with a botanical section which enables the student, one cannot say reader, (for merely reading would not be sufficient), but the man who studies it, to get a clear conception of the structure of grasses, and of their classification. All the important Species are next described.

The second part of the book is devoted to the Agricultural aspect of the subject.

As the author says :—

"It must be acknowledged that each of our cultivated grasses has a special value of its own for particular circumstances of soil, climate, and agricultural requirements. Our aim, therefore, should always be to place each species under the conditions for which it is best adapted, for by so doing its greatest agricultural value will be realised."

Consequently in the first chapter of the Agricultural Section these special conditions and requirements are as far as possible indicated for each species.

The valuation and purchase of grass seeds, the compounding of seed-mixtures, sowing, and the effects of manures are considered, and the book ends with a Bibliography of the most valuable literature on the subject which the student may consult.

The illustrations are numerous and excellent, and the work is admirably printed. Author and publisher have combined to produce a work of great practical utility to the student of grasses and one worthy of a place in the farmer's library.

Nature Study.

13.—*Short Nature-studies.* By Prof. L. C. Miall, F.R.S.

14.—*Farm Spies.* By Conradi and Thomas.

These are both published by Macmillan & Co., the former being written by a well-known English professor, the latter by two American professors.

It takes us a long time to accept and realise the value of any new study, but at last the importance of Nature-study appears to be recognised. Books on the subject are numerous and varied in character, some too simple, some too hard to be easily understood. They are generally illustrated, as they should be, but some of the illustrations have to be taken for granted unless, which is probably very rarely, students have access to a good microscope. Nature studies should not be reading lessons, but observation lessons. They should proceed from what is visible to the eye of any intelligent child to what is visible with a pocket lens; then to what can be

seen under a low power of a simple microscope, and finally the minute structure should be shown to, or rather arrived at, by the more advanced students as the result of their own work, when from experience in microscopical manipulation they are sufficiently advanced to use the higher powers of the microscope.

Books on Nature study may thus be divided into two classes, Reading Books and Field or Bench books; using the term bench to represent the work done in the study with dissecting tools, lens or microscope.

Both the books under notice belong to the first class. That by Prof. Miall is most interesting and covers a great variety of subjects. It has one special advantage, that it takes the subjects in the order in which they are most likely to attract attention, starting on January 4th and ending on December 21st. Hence one title to the book is "Round the Year."

The American book deals in part with insects peculiar to the cotton plant, so that it is not quite so attractive to readers in Great Britain.

Both are well illustrated. They prove the charm which Nature study always possesses, and how, apart from the objects themselves, the mere description of the wonders of Nature, when given by a master of his subject, is capable of holding the reader as strongly as any fictitious romance.

15.—*English Farming, Past and Present.* By R. E. PROTHERO. London: Longmans, Green & Co. 7s 6d.

This book is a reprint brought out at a very reasonable price of a work which when it appeared in 1912 was drawn attention to in this Journal. Since then the author has become the Minister of Agriculture and has proved, at the most critical period of our history, how thoroughly he understands not only what English farming was in the past, but what it is now, and what it is capable of becoming.

History when wisely studied always affords help in present troubles. It shows us what difficulties our ancestors had to deal with and how they overcame them, and it inspires us to strive to overcome our difficulties. We, therefore, can strongly advise those who have not already this valuable work to obtain it and study it carefully.

16.—*Soil Conditions and Plant Growth.* By Dr. E. J. Russell. London: Longmans, Green & Co. 6s. 6d.

This book, originally published in 1912, has so rapidly taken its place as a standard work that already a third edition has been called for. This has afforded the author an opportunity to make considerable alterations in the text and to add a new chapter in which the colloidal properties of the soil are discussed. These colloidal properties of soils have long been known to scientists, and the more they are studied the more important they appear to be, so that the author considers "that much of the older work upon soils will require careful re-examination in the light of what has been done by chemists and physicists" in the study of colloidal action.

The book is replete with all the latest work which has been done by scientists in the study of the soil. That portion dealing with the action of Bacteria is especially interesting. Intended and suitable mainly for students and for those who have already a sound knowledge of the sciences, especially chemistry, which bear upon the subject, it is not a book which the ordinary farmer could appreciate, but is one which should be studied by every worker in the domain of agricultural science.

17.—*Cackles and Lays.* Written by Margaret Lavington, illustrated by Helen Urquhart. London: John Lane. 2s. 6d.

In the days of my boyhood, verse was often requisitioned for the purpose of impressing upon our youthful imaginations certain facts, which, as a matter of education, it was deemed desirable we should get a firm grip of. By the aid of such a medium, we were enabled to remember the number of days in each month of the year, the signs of the zodiac and other items of similar utility. When a youngster, I was presented with a history of England in which the characteristics of the different monarchs and the principal events of their reigns were described in rhyming couplets, but, its study not being compulsory, I am bound to admit that I did not take advantage of such assistance. "Cackles and Lays" is responsible for this revival of school-day memories, inasmuch as, in guise poetical, it gives much practical information with respect to poultry-

keeping. At the same time, it must be admitted that its chief claim for attention lies in the genuine and abundant humour of both letterpress and illustrations. These display an intimate acquaintance with the manners and customs, the likes and dislikes, of the cock-and-hen world set forth with so much point and piquancy that the ordinary reader, whose interest in poultry is generally confined to enjoying it in a cooked state, will be abundantly rewarded for studying its living idiosyncrasies as they are here presented. So happy is the combination of author and illustrator that it would be as difficult to decide to which of the two the palm of superiority should be awarded as it would be to discriminate between Gilbert and Sullivan; it is a case of "honours divided." The book is most attractively and artistically got-up, and, in view of this, one marvels how, in these difficult times, it can be issued at the price.

18.— PAMPHLETS.

One of the results of the War has been to cause a large number of small booklets or pamphlets to be issued on subjects of present interest which do not need lengthy treatment. We have received a goodly number of these which merely call for brief notice so that those interested in the subjects may know where to seek for information.

The National Food Supply in Peace and War, 6d.; and

Composition and Nutritive Value of Feeding Stuffs, 1s.

Are both written by Prof. T. B. WOOD, of Cambridge, and published by the Cambridge University Press.

Opinions differ so greatly with respect to what ought to be the policy of this country as regards food supply that it would require an entire article to discuss Prof. Wood's views. Suffice it to say that they are certainly open to criticism, though they appear to have largely affected the policy of those who have the control of this momentous problem.

The tables setting forth the Composition of Feeding Stuffs are mainly interesting to stock-farmers, who will find very valuable statistics as to the composition, digestible nutrients, nutritive ratio, food units, etc., of all ordinary feeding stuffs. We are surprised that a Cambridge professor should write of Bye products, as we were under the impression it was universally decided to call these By-products.

The Vegetable Garden, 1s. 6d. By E. J. S. LAY, published by Macmillan & Co., belongs to the Pupils' Class-book Series, is intended for children and gives concise and accurate information. It contains many useful illustrations.

British Forestry, past and future. By PROF. W. SOMERVILLE, 6d., is issued by the Oxford University Press. It sets forth what has been done in the past. How little that is, in spite of all the efforts which have been made to show the necessity of paying more attention to forestry, people are now beginning to realize. As the author says, "the war has shown that industries vital to national security may be paralysed if deprived of supplies of timber." We commend this pamphlet to large landowners, especially those with land suitable for afforestation, and also to politicians. It is too late now to do anything for the needs of to-day. "The present situation," as Dr. Somerville says, "supplies another illustration of the result of lack of foresight on the part of successive governments." Let us hope that this state of affairs may be remedied in the future, whether along the lines suggested by the author or by any better system if it should be proposed.

A Good Living from Poultry. By F. G. PAYNTER, 1s., published by Geo. Newnes, Ltd., is an attempt to show how disabled soldiers and others should set about keeping poultry so as to make them profitable, and is especially written for the small holder. The conditions which now prevail regarding food and other expenses would materially affect the author's figures, but the principles will hold good and readers would have to judge for themselves how far they could be applied at present.

Agriculture and the Land. By G. F. BOSWORTH, 1s. 6d., is one of the Cambridge Industrial and Commercial Series, published at the University Press. The series is intended for school children, and is based on the assumption that "Industrial and Commercial prosperity does not, in itself, constitute greatness, but it is a condition without which national greatness is impossible. Hence the story of the industrial and commercial condition of Britain is worth telling to our school children, not only that they may rejoice in our country's progress, but also that they may realise the responsibilities borne by the citizens of the first of all nations."

The chief fault we have to find with the author is the bumptious tone in which the book is written. This is illustrated in the last few words above quoted, and is found in several other sentences interspersed about the book. The tendency of such language is to

increase in children a trait already far too pronounced, that of thinking we are quite unique people, far superior to the rest of the world. The more we know of other people the less we think in this way. But it has a baneful effect upon youth. It seems to infer that we have done such wonders that there is little hope of improvement or progress. While we all admire what has been done by our ancestors, the great aim in education should be to inspire students to do more by showing them that much has yet to be done, and is being done by those who work and learn.

Apart from this criticism the book is interesting and well illustrated, it puts before readers varied information not easily gathered elsewhere, and in some parts treats of subjects sufficiently difficult to necessitate careful thought on the part of readers.

APPENDIX.

Bath and West and Southern Counties Society.

OBJECTS OF THE SOCIETY AND PRIVILEGES OF MEMBERSHIP.

ANNUAL EXHIBITIONS.

The Society annually holds an Exhibition in some city or town in England or Wales. Each section of the Society's district is visited at intervals, so that most Members have an opportunity of seeing the Show in their own neighbourhood every few years. Prizes to a large amount are given for Horses, Cattle, Sheep, Pigs, Farm Produce, &c. Provision is also made for the exhibition of Agricultural Implements and Machinery, Seeds, Cattle Foods, Artificial Manures, and articles of general utility. A substantially built and completely equipped Working Dairy on a large scale is a special feature of these Exhibitions. Here explanatory demonstrations and comparative tests of implements and processes are carried on, with the assistance of well-known practical and scientific experts, and Butter-making Competitions are held. Among the features of the Annual Meeting are Shoeing, Milking and other Competitions, Poultry and Horticultural Shows, and Exhibitions illustrative of Bee-keeping, Home Industries, Art-Manufactures, Nature Study and Forestry.

Membership entitles to free admission to the Annual Exhibition, and also to the Grand Stand overlooking the Horse and Cattle Ring, to the Reserved Seats in the Working Dairy, and to the use of the Members' Special Pavilion for Luncheons, Reading, Writing, &c.

Entries can be made by Members (elected on or before the last Tuesday in January preceding the Show) at half the Fees payable by Non-Members.

THE JOURNAL.

All Members receive free of charge the Society's Journal, which is published annually bound in cloth. It has for its aim the dissemination of agricultural knowledge in a popular form, and, in addition to original articles by well-known agricultural authorities, it contains particulars of the Society's general operations, full reports of its experimental and research work, prize awards, financial statements, lists of Members, reviews of new books on agriculture, &c. (The price of the *Journal* to non-Members is 6s. 5d. post free.)

CHEMICAL AND OTHER FACILITIES.

The Society has a Consulting Chemist *from whom Members can obtain analyses and reports at reduced rates of charge.* An arrangement has also been made under which Members of the Society can obtain, free of charge, from the National Fruit and Cider Institute at Long Ashton, analyses of cider-apples and perry-pears, and, with a view to assisting farmers and others in dealing with insect and other pests which affect agriculture, horticulture, &c., the Council have availed themselves of an offer from the Board of Economic Biology of the University of Bristol to investigate the nature of any insect or other pest and report upon it free of charge.

EXPERIMENTS.

Experiments on crops are conducted at experimental stations in various parts of the Kingdom, and *Members are enabled to take part in these and to receive reports thereon.*

ART-MANUFACTURES, NATURE STUDY, FORESTRY, &c.

One of the objects for which the Society was founded was the encouragement of Arts as well as Agriculture, and, to this end, exhibitions are held of Art-Manufactures and of work representative of Arts and Handicrafts. Exhibitions are also held illustrating Nature Study, as a branch of Education; the Science of Forestry, &c.

TERMS OF MEMBERSHIP.

ANNUAL SUBSCRIPTIONS.

Governors, not less than	£2
Ordinary Members, not less than	£1
Tenant Farmers, the rateable value of whose holdings does not exceed £200 a-year, not less than	10s.

Governors, who are eligible for election as President or Vice-President, are entitled, in addition to the privileges already mentioned, to an extra Season Ticket for the Annual Exhibition and for the Grand Stand, &c. Governors subscribing more than £2 are entitled to a further Ticket for every additional £1 subscribed.

Members subscribing less than £1 are entitled to all the privileges of Membership except that of entering Stock at reduced fees, and their admission Ticket for the Annual Show is available for *one day only* instead of for the whole time of the Exhibition.

LIFE COMPOSITIONS.

Governors may compound for their Subscription for future years by payment, in advance, of £20; and Members by payment, in advance, of £10. Governors and Members who have subscribed for twenty years may become Life Members on payment of half these amounts.

Any person desirous of joining the Society can be proposed by a Member, or by

THOS. F. PLOWMAN,
Secretary and Editor.

3, Pierrepont Street, Bath.

Telegraphic Address—"PLOWMAN, BATH."

Telephone No. 610.

Bath and West and Southern Counties Society.

GENERAL LAWS.

As revised in accordance with the Report of a Special Committee; which Report was received and adopted by the Annual General Meeting of Members, held on May 30, 1895.

COMPOSITION OF THE SOCIETY.

I. The Society shall consist of a President, Vice-Presidents, Trustees, Council, Treasurer, Secretary, and Members.

OBJECTS.

II. The Society shall have the following objects :—

a. To hold Exhibitions of breeding stock, agricultural implements, and such other articles connected with agriculture, arts, manufactures or commerce, as may be determined upon by the Council.

b. To conduct practical and scientific investigations in agriculture.

c. To promote technical education in agriculture by providing means of systematic instruction.

d. To publish a Journal for circulation.

SUBSCRIPTIONS.

III. The Annual Subscription for Members shall be as follows :—

Governors (who are eligible for election as President or Vice-President), not less than	£2
Ordinary Members, not less than	£1
Tenant Farmers (the rateable value of whose holdings does not exceed £200 a-year), not less than	10*s*.

IV. The payment of £20 in one sum shall constitute a Governor for life, and of £10 in one sum an Ordinary Member for life ; but any Governor who has subscribed not less than £2 annually for a period of twenty years may become a Life Governor on the further payment of £10 in one sum ; and any Ordinary Member, who has subscribed not less than £1 annually for the same period may become a Life-Member on the further payment of £5 in one sum.

V. Subscriptions shall become due and be payable in advance on the 1st of January in each year or as soon as the Subscriber has been elected a Member. When the election takes place during the last quarter of the year the subscription payable on election will be considered as applying to the ensuing year.

VI. A Member shall be liable to pay his subscription for the current year unless he shall have given notice, in writing, to the Secretary before January 1st of his intention to withdraw.

GOVERNING BODY.

VII. The entire management of the Society—including the making of Bye-laws, election of Members, determining the Prizes to be awarded, appointing Committees, fixing the Places of Meetings and Exhibitions, appointing or removing the Treasurer, Secretary, and such other officers as may be required to carry on the business of the Society—shall be vested in the Council, who shall report its proceedings at the Annual Meetings of the Society.

VIII. The Council shall consist of the Patron (if any), President, Vice-Presidents, Trustees, and Treasurer (who shall be *ex-officio* Members), and of sixty-six elected Members.

ELECTION OF PRESIDENT, VICE-PRESIDENTS, TRUSTEES, AND COUNCIL.

IX. The election of a President for the year, of any additional Vice-Presidents or Trustees, and of the Members of Council representing the Divisions named in Law X., shall take place at the Annual Meeting of the Society, and they shall enter into office at the conclusion of the Exhibition during which such Annual Meeting has been held.

X. The sixty-six Members of the Council referred to in Laws VIII. and IX. shall consist of fifty-eight persons residing or representing property in the following Divisions, viz. :—

Twelve from the Counties of Devon and Cornwall, which shall be called the Western Division ;

Twenty-four from the Counties of Somerset, Dorset, and Wilts, which shall be called the Central Division ;

Twelve from the Counties of Hants, Berks, Oxon, Bucks, Middlesex, Surrey, Sussex, and Kent, which shall be called the Southern Division ; and

Ten from the Counties of Worcester, Gloucester, Hereford and Monmouth, and the Principality of Wales, which shall be called the North-Western Division.

The remaining eight shall be elected (irrespective of locality) from the general body of members, and shall form a Division which shall be called the "Without Reference to District" Division.

XI. One-half of the elected Members in each of the five Divisions named in Law X. shall retire annually by rotation, but shall be eligible for re-election.

XII. The Council shall have power to nominate a President, Vice-Presidents, Trustees, and Members of Council for the approval of the Annual Meeting, and to fill up such vacancies in their own body as are left after the Annual Meeting, or as may from time to time occur during the interval between the Annual Meetings.

XIII. Nominations to offices, election to which is vested in the whole body of Members, must reach the Secretary ten days before the meeting at which such vacancies are to be filled up.

MEETINGS.

XIV. The Annual Meeting of the Society shall take place during the holding of the annual Exhibition.

XV. Special General Meetings of the Society may be convened by the President on the written requisition of not less than three Members of Council; and all Members shall have ten days' notice of the object for which they are called together.

XVI. No Member of less than three months' standing, or whose subscription is in arrear, shall be entitled to vote at a Meeting.

EXHIBITIONS.

XVII. The Annual Exhibitions of the Society shall be held in different Cities or Towns in successive years.

XVIII. All Exhibitors shall pay such fees as may be fixed by the Council. Members subscribing not less than £1 per annum, who have been elected previous to February 1st, and have paid the subscription for the current year, shall be entitled to exhibit at such reduction in these fees as the Council shall determine.

PRIZES.

XIX. All prizes offered at the cost of the Society shall be open for competition to the United Kingdom.

XX. No person intending to compete for any prize offered at the annual Exhibition shall be eligible to act as a judge or to have any voice in the selection of judges to award the premiums in the department in which he exhibits.

XXI. If it be proved to the satisfaction of the Council that any person has attempted to gain a prize in this, or in any other society, by a false certificate or by a misrepresentation of any kind, such person shall thereupon be, for the future, excluded from exhibiting in this Society.

JOURNAL.

XXII. The Proceedings of the Society, Awards of Prizes, Financial Statements and Lists of Officers, Governors, and Members, shall be printed annually in the Society's *Journal*, and every Governor and Member, not in arrear with his subscription, shall be entitled to receive one copy, free of expense, and there shall be an additional number printed for sale.

POLITICS.

XXIII. No subject or question of a political tendency shall be introduced at any Meeting of this Society.

ALTERATIONS IN LAWS.

XXIV. No new General Law shall be made or existing one altered, added to or rescinded, except at an Annual or Special General Meeting, and then only provided that a statement of particulars, in writing, shall have been sent to the Secretary at least twenty-one days previous to the Meeting at which the question is to be considered.

List of Officers,

1917-1918.

PATRON.

HIS MOST GRACIOUS MAJESTY THE KING.

PRESIDENT.

THE RIGHT HON. THE EARL OF COVENTRY.

TRUSTEES.

*Bath, The Marquis of, K.G., Longleat, Warminster.
Acland, Sir C. T. D., Bart., Killerton, Exeter.
Edwards, C. L. F., The Court, Axbridge, Somerset.

VICE-PRESIDENTS.

Acland, Sir C. T. D., Bart.	Killerton, Exeter
Allen, J. D.	Springfield House, Shepton Mallet
Badcock, H. J.	Broadlands, Taunton
Baker, G. E. Lloyd	Hardwicke Court, Gloucester
*Bath, Marquis of, K.G.	Longleat, Warminster
*Beaufort, Duke of	Badminton, Chippenham
Benyon, J. Herbert	Englefield House, Reading
*Bute, Marquis of	The Castle, Cardiff
*Clinton, Lord	Heanton Satchville, Dolton, N. Devon
Devonshire, Duke of	Chatsworth, Derbyshire
*Digby, Lord	Minterne, Cerne Abbas
*Ducie, Earl of	Tortworth, Falfield, R.S.O.
Edwards, C. L. F.	The Court, Axbridge, Somerset
*Falmouth, Viscount	Tregothnan, Truro
Hambleden, Viscount	Greenlands, Henley-on-Thames
Hobhouse, Right Hon. H.	Hadspen House, Castle Cary
*Lansdowne, Marquis of, K.G.	Bowood, Calne
*Llewelyn, Sir J. T. D., Bart.	Penllergaer, Swansea
Moreton, Lord	Sarsden House, Chipping Norton
Neville Grenville, R.	Butleigh Court, Glastonbury
Northumberland, Duke of	Albury Park, Guildford
*Plymouth, Earl of	Hewell Grange, Bromsgrove
Poltimore, Lord	Poltimore Park, Exeter

[*** Those to whose names an asterisk (*) is prefixed have filled the office of President.

VICE-PRESIDENTS—*continued.*

*PORTMAN, VISCOUNT	Bryanston, Blandford
*RADNOR, EARL OF	Longford Castle, Salisbury
SHELLEY, SIR J., Bart.	Shobrooke Park, Crediton
SILLIFANT, A. O.	Culmleigh, Stoke Canon, Exeter
SOMERSET, DUKE OF	Maiden Bradley, Bath
STRACHIE, LORD	Sutton Court, Pensford, Somerset
TEMPLE, EARL	Newton St. Loe, Bristol
WALERAN, LORD	Bradfield, Cullompton

THE LORD WARDEN OF THE STANNARIES.

THE SECRETARY AND KEEPER OF THE RECORDS OF THE DUCHY OF CORNWALL.

THE RECEIVER-GENERAL OF THE DUCHY OF CORNWALL.

*** Those to whose names an asterisk (*) is prefixed have filled the office of President.

MEMBERS OF COUNCIL.

EX-OFFICIO MEMBERS.

THE PATRON.
THE PRESIDENT.
THE VICE-PRESIDENTS.
THE TRUSTEES.
THE TREASURER.

ELECTED MEMBERS.

WESTERN DIVISION (DEVON AND CORNWALL).

(12 *Representatives.*)

Elected in 1916.

Name.	*Address.*
BAYLY, J.	Highlands, Ivy Bridge, S. Devon
BUCKINGHAM, REV. PREB.	The Rectory, Doddiscombsleigh, Exeter
GIBBS, A. H.	11, Marlborough Buildings, Bath
MOORE-STEVENS, COL. R. A.	Winscott, Torrington, Devon
SHELLEY, J. F.	Posbury House, Crediton
STUDDY, T. E.	Mazonet, Stoke Gabriel, Totnes

Elected in 1917.

Name.	*Address.*
BOSCAWEN, REV. A. T.	Ludgvan Rectory, Long Rock, R.S.O., Cornwall
DAW, J. E.	Exeter
LEVERTON, W.	Woolleigh Barton, Beaford, N. Devon
LOPES, SIR HENRY Y. B., Bart.	Maristow, Roborough, S. Devon
MARTYN G.	Liskeard, Cornwall
MORLEY, EARL OF	Saltram, Plympton, Devon

CENTRAL DIVISION (SOMERSET, DORSET, AND WILTS).

(24 *Representatives.*)

FOX, R. A.	Yate House, Yate, Glos.
GIBSON, J. T.	Warren House, Wrington
MAULE, M. ST. J.	Chapel House, Bath
NAPIER, H. B.	Long Ashton, Clifton, Bristol
NICHOLS, G.	49, Broad Street, Bristol
PARRY-OKEDEN, LT.-COL. U. E. P.	Turnworth, Blandford, Dorset
SANDERS, R. A., M.P.	Barwick House, Yeovil
TUDWAY, C. C.	The Cedars, Wells, Somt.
WYNFORD, LORD	Wynford House, Marden Newton, Dorset
CLARK, W. H.	Rutland Cottage, Combe Down, Bath
FARWELL, E. W.	Queen's Parade, Bath
GORDON, G. H.	The Barn House, Sherborne, Dorset
HILL, V. T.	Mendip Lodge, Langford, Bristol
HOARE, SIR H. H. A., Bart.	Stourhead, Zeals, S.O., Wilts
HURLE, J. C.	Brislington Hill, Bristol
KNIGHT, S. J.	Walnut Farm, East Dundry, Bristol
RAWLENCE, E. A.	Newlands, Salisbury
RAWLENCE, G. N.	Salisbury
SOMERVILLE, A. F.	Dinder House, Wells
WATSON, HON. T. H.	Cormiston, Milverton, Somt.
WHITE, A. R.	Charnage, Mere, Wilts

SOUTHERN DIVISION (HANTS, BERKS, OXON, BUCKS, MIDDLESEX, SURREY, SUSSEX AND KENT).

(12 *Representatives.*)

BEST, MAJOR T. G.	East Carleton Manor, Norwich
BYNG, COL. HON. C.	Cavalry Club, 127, Piccadilly, London, W.
JERVOISE, F. H. T.	Herriard Park, Basingstoke
LATHAM, T.	Dorchester, Oxon
RUTHERFORD, J. A.	Highclere Estate Office, Newbury
SUTTON, E. P. F.	Sidmouth Grange, nr. Reading
ASHCROFT, W.	13, The Waldrons, Croydon
BURRELL, SIR M. R., Bart.	Knepp Castle, Horsham, Sussex
COBB, H. M.	Higham, Kent
CUNDALL, H. M., I.S.O., F.S.A.	4, Marchmont Gardens, Richmond, Surrey
DRUMMOND, H. W.	Board Room L.& S.W.R., Waterloo Stn., London.
LLEWELLYN, L. T. E.	Hackwood, Basingstoke

NORTH-WESTERN DIVISION (WORCESTERSHIRE, GLOUCESTERSHIRE, HEREFORDSHIRE, MONMOUTHSHIRE AND WALES).

(10 *Representatives.*)

ALLSEBROOK, A	Link Elm, Malvern Link
BEST, CAPT. W.	Vivod, Llangollen
COTTERELL, SIR J., Bart.	Garnons, Hereford
LIPSCOMB, G.	Margam Park Estate Office, Port Talbot
MASON, F. F.	Swansea
ACKERS, C. P.	Huntley Manor, Gloucester
ALEXANDER, D.	Cardiff
ALEXANDER, H. G.	5, High Street, Cardiff
BATHURST, Sir C., M.P.	Lydney Park, Gloucester
DRUMMOND, Col. F. D. W.	Cawdor Estate Office, Carmarthen

WITHOUT REFERENCE TO DISTRICT DIVISION.

(8 *Representatives.*)

ACLAND, Rt. Hon. F. DYKE	93, Bedford Gardens, Campden Hill, London, W.
KNOLLYS, C. R.	Weekley, Kettering
PORTMAN, HON. C. B.	Goldicote, Stratford-on-Avon
WILLIAMS, JOHN	Scorrier House, Scorrier, Cornwall
EVANS, H. M. G.	Plassissa, Llangennech, Carmarthen
LEWIS, COL. H.	Green Meadow, near Cardiff
MASTERS, A.	Kyneton, Thornbury, Glos.
WILLIAMS, JESTYN	Llanover Estate, Newport, Mon.

STANDING COMMITTEES, 1917-1918.

[The President is an *ex-officio* Member of all Committees.]

ALLOTMENT.

Edwards, C. L. F., *Chairman.*

Bath, Marquis of, K.G.
Best, Capt. W.
Byng, Col. Hon. C.
Mason, F. F.
Napier, H. B.
Studdy, T. E.
Wynford, Lord

CONTRACTS.

Napier, H. B., *Chairman.*

Allsebrook, A.
Bath, Marquis of, K.G.
Best, Capt. W.
Daw, J. E.
Edwards, C. L. F.
Mason, F. F.
Neville Grenville, R.
Rawlence, G. N.
Studdy, T. E.

DAIRY

Acland, Sir C. T. D., Bart., *Chairman.*

Somerville, A. F., *Vice-Chairman.*

Allen, J. D.
Ashcroft, W.
Boscawen, Rev. A. T.
Clark, W. H.
Gibbs, A. H.
Gibson, J. T.
Hurle, J. Cooke
Knight S. J.
Latham, T.
Llewellyn, L. T E
Napier, H. B.
Neville Grenville, R.
Strachie Lord
Tudway, C. C.

DISQUALIFYING.

The Stewards of Live Stock and Produce.

EXPERIMENTS AND EDUCATION.

Acland, Sir C. T. D., Bart., *Chairman.*

Allen, J. D.
Ashcroft, W.
Baker, G. E. Lloyd
Bathurst, Sir C., M.P.
Benyon, J. H.
Gibson, J. T.
Hobhouse, Rt. Hon. H.
Hurle, J. Cooke
Latham, T.
Neville Grenville, R.
Rawlence, E. A.
Rutherford, J. A.
Somerville, A. F.

(With power to add to their number.)

FINANCE.

Napier, H. B., *Chairman.*

Daw, J. E.
Gibbs, A. H.

FORESTRY.

Lipscomb, G., *Chairman.*

Ackers, C. P.
Acland, Sir C. T. D., Bart.
Clinton, Lord
Drummond, Col. F. D. W.
Duchesne, M. C.
Evans, H. M. G.
Hoare, Sir H. H. A., Bart.
Napier, H. B.
North, G. F.
Rutherford, J. A.

IMPLEMENT REGULATIONS.

SHELLEY, SIR J., Bart., *Chairman.*

ACLAND, SIR C. T. D., Bart.
BATH, MARQUIS OF, K.G.
BEST, CAPT. W.
EDWARDS, C. L. F.
MARTYN, G.
MASON, F. F.
MOORE-STEVENS, COL. R. A.
NAPIER, H. B.
NEVILLE GRENVILLE, R.
STUDDY, T. E.

JOURNAL.

ACLAND, Sir C. T. D., Bart., *Chairman.*

BAKER, G. E. LLOYD
BATHURST, SIR C., M.P.
HOBHOUSE, RIGHT HON. H.

JUDGES' SELECTION.

SILLIFANT, A. O., *Chairman.*

ALEXANDER, D.
ALEXANDER, H. G.
ALLEN, J. D.
ASHCROFT, W.
BYNG, COL. HON. C.
GORDON, G.
HOARE SIR H. H. A., Bart.
LATHAM, T.
MOORE-STEVENS, COL. R. A.
PARRY-OKEDEN, LIEUT.-COL. U. E. P.
SHELLEY, SIR J., Bart.
WYNFORD, LORD

RAILWAY ARRANGEMENTS AND ADVERTISEMENTS.

ALEXANDER, D.
COVENTRY, EARL OF
DRUMMOND, H. W.
MASON, F. F.
SHELLEY SIR J., Bart.

(With power to add to their number.)

SCIENCE AND ART.

BATH, MARQUIS OF, K.G.; *Chairman.*

ACLAND, SIR C. T. D., Bart.
CUNDALL, H. M. (I.S.O., F.S.A.)
DAW, J. E.
EVANS, H. M. G.
FARWELL, E. W.
HOBHOUSE, RT. HON. H.
LEGARD, A. G.
LIPSCOMB, G.
LLEWELYN, SIR J. T. D., Bart.
NAPIER, H. B.
RUTHERFORD, J. A.

(With power to add to their number.)

SELECTION.

THE CHAIRMEN OF ALL OTHER COMMITTEES.

SHOW PLACE AND DATE.

CHAIRMEN OF THE ALLOTMENT, CONTRACTS, DAIRY, FINANCE, FORESTRY, IMPLEMENT REGULATIONS, RAILWAY ARRANGEMENTS, SCIENCE AND ART, AND STOCK PRIZE SHEET COMMITTEES.

(With power to add two Local Members to their number.)

STOCK PRIZE SHEET.

SILLIFANT, A. O., *Chairman.*

ALEXANDER, D.
ALEXANDER, H. G.
ALLEN, J. D.
ALLSEBROOK, A.
ASHCROFT, W.
BUCKINGHAM, REV. PREB.
BYNG, COL. HON. C.
CLARK, W. H.
COTTERELL, SIR J., Bart.
EVANS, H. M. G.
GIBBS, A. H.
HOARE, SIR H. H. A., Bart.
LATHAM, T.
LEVERTON, W.
MOORE-STEVENS, COL. R. A.
PORTMAN, HON. C. B.
SHELLEY, SIR J., Bart.
SUTTON, E. P. F.
WHITE, A. R.
WILLIAMS, JESTYN
WYNFORD, LORD

WORKS.

EDWARDS, C. L. F., *Chairman.*

BATH, MARQUIS OF, K.G.
BEST, CAPT. W.
NAPIER, H. B.
STUDDY, T. E.

Stewards.

Cattle, Sheep and Pigs.

ASHCROFT, W.
MOORE-STEVENS, COL. R. A.

Cider.

FARWELL, E. W.

Dairy.

SOMERVILLE, A. F.

Experiments.

ASHCROFT, W.

Finance.

DAW, J. E.
NAPIER, H. B. GIBBS, A. H.

Forestry.

LIPSCOMB, G.

Horses.

ALEXANDER, D.
WYNFORD, LORD

Horticulture.

BOSCAWEN, REV. A. T.

Poultry.

STUDDY, T. E.

Science and Art and Music.

CUNDALL, H. M. (I.S.O., F.S.A.)

Shoeing.

LATHAM, T.

Yard.

EDWARDS, C. L. F.
BEST, CAPT. W.
BATH, MARQUIS OF, K.G.
STUDDY, T. E.

Other Honorary Officials.

Treasurer—LUTTRELL, C. M. F.

Chaplain.

BOSCAWEN, REV. A. T.

Permanent Officials.

Secretary and Editor—PLOWMAN, THOMAS F.

Associate Editor.

LLOYD, F. J. (F.C.S.)

Auditor.

GOODMAN, F. C. (*Chartered Accountant*)

Consulting Chemist.

VOELCKER, DR. J. A. (M.A., F.I.C.)

Veterinary Inspector.

PENBERTHY, Prof. J. (F.R.C.V.S.)

Superintendent of Works.

AYRE, H. C.

Annual Exhibitions.

Year.	Place Visited.	Local Subscription.	Prizes.			Total Local Contribution.	President.	Admissions.		
			Local Committee.	Local Societies	Local Residents.			On 2/6 Days.	On 1/- Days.	Total.
		£	£	£	£	£				
1852	Taunton	210	..	..	..	210	Lord Portman	..	..	..
1853	Plymouth	450	..	..	..	450	Sir T. D. Acland, Bart.	..	..	..
1854	Bath	450	..	..	..	450	William Miles, M.P.	..	..	..
1855	Tiverton	450	..	..	..	450	Earl Fortescue	..	..	..
1856	Yeovil	450	..	..	..	450	C. A. Moody, M.P.	..	..	..
1857	Newton Abbot	700	..	..	..	700	Lord Courtenay	..	..	..
1858	Cardiff	800	..	..	..	800	Lord Courtenay	..	..	..
1859	Barnstaple	800	85	..	81	966	John Sillifant	..	..	..
1860	Dorchester	900	..	..	..	900	Lord Rivers	10,709	11,949	22,658
1861	Truro	900	..	..	..	900	J. W. Buller, M.P.	15,201	14,220	29,421
1862	Wells	900	..	..	..	900	Sir T. D. Acland, Bart.	10,578	4,775	15,353
1863	Exeter	900	..	..	..	900	Marquis of Bath	15,635	19,284	34,919
1864	Bristol	1000	106	..	50	1156	Earl Fortescue	22,377	65,678	88,055
1865	Hereford	900	358	..	..	1258	Lord Taunton	16,575	35,261	51,836
1866	Salisbury	900 }	57	..	..	957	{ Earl of Portsmouth	7,288	18,737	26,025
1867	Salisbury	.. }					{ J. Tremayne	7,502	16,702	24,204
1868	Falmouth	900	..	..	..	900	Sir J. T. B. Duckworth, Bart.	11,393	19,495	30,888
1869	Southampton	900	132	..	18	1050	Earl of Carnarvon	15,340	41,290	56,630
1870	Taunton	900	..	..	..	900	Sir S. H. Northcote, Bart., C.B., M.P.	17,952	33,653	51,605
1871	Guildford	900	110	..	..	1010	Earl of Cork	10,656	23,406	34,062
1872	Dorchester	800	..	..	10	810	Duke of Marlborough, K.G.	12,791	21,517	34,308
1873	Plymouth	800	..	400	..	1200	Earl of Mount-Edgcumbe.	16,665	45,744	62,409
1874	Bristol	800	403	..	..	1203	Sir Massey Lopes, Bart., M.P.	37,329	72,791	110,120
1875	Croydon	800	245	..	..	1045	R. Benyon, M.P.	14,518	26,028	40,546
1876	Hereford	800	381	..	..	1181	Earl of Ducie	16,396	32,645	49,041
1877	Bath	800	215	..	..	1015	Marquis of Lansdowne	27,625	48,852	76,477
1878	Oxford	800	..	170	6	976	Earl of Jersey	12,414	26,995	39,409

Annual Exhibitions—*continued.*

Year.	Place Visited.	Local Subscription.	Prizes. Local Committee.	Prizes. Local Societies	Prizes. Local Residents.	Total Local Contribution.	President.	Admissions. On 5/- Day.	Admissions. On 2/6 Days.	Admissions. On 1/- Days.	Admissions. Total.
		£	£	£	£	£					
1879	Exeter	800	..	..	10	810	Earl of Morley	..	14,634	40,533	55,167
1880	Worcester	800	..	254	..	1054	Earl of Coventry	..	8,415	37,675	46,090
1881	Tunbridge Wells	800	245	34	..	1079	Marquis of Abergavenny	..	13,368	33,236	46,604
1882	Cardiff	800	200	198	17	1215	Lord Tredegar	..	23,941	38,680	62,621
1883	Bridgwater	800	78	..	..	878	Lord Brooke, M.P.	..	17,171	31,241	48,412
1884	Maidstone	800	310	33	75	1218	Viscount Holmesdale	..	13,501	31,053	44,554
1885	Brighton	800	227	33	82	1142	Viscount Hampden	..	9,637	39,851	49,488
1886	Bristol	800	525	..	..	1325	Lord Carlingford	..	29,580	70,999	100,579
1887	Dorchester	800	..	112	..	912	Earl of Ilchester	..	8,860	29,846	38,706
1888	Newport (Mon.)	800	100	..	..	900	Lord Tredegar	..	14,878	38,567	53,445
1889	Exeter	800	..	..	10	810	Lord Clinton	..	16,405	36,195	52,600
1890	Rochester	800	294	..	26	1120	Earl of Darnley	..	3,480	48,314	51,794
1891	Bath	800	50	103	100	1053	Earl Temple	..	23,510	52,185	75,695
1892	Swansea	800	200	100	10	1110	Sir J. D. T. Llewelyn, Bart.	..	18,364	54,609	72,973
1893	Gloucester	800	400	..	..	1200	Lord Fitzhardinge	..	14,272	40,368	54,640
1894	Guildford	800	174	..	10	984	Earl of Onslow	..	8,671	29,813	38,484
1895	Taunton	800	85	160	10	1055	Viscount Portman	..	13,181	30,111	43,292
1896	St. Albans	800	152	..	..	952	Earl of Clarendon	..	12,056	22,380	34,436
1897	Southampton	800	50	..	..	850	Lord Montagu of Beaulieu	..	8,284	33,750	42,034
1898	Cardiff	800	200	..	..	1000	Lord Windsor	..	13,101	42,501	55,602
1899	Exeter	800	..	225	5	1030	Lord Clinton	..	16,091	39,832	55,923
1900	Bath	800	100	150	10	1060	Marquis of Bath	954	11,601	36,814	49,369
1901	Croydon	800	115	..	..	915	H.R.H. The Duke of Cornwall and York, K.G.	1,196	9,362	30,693	41,251
1902	Plymouth	800	105	100	36	1041	Earl of Morley	842	12,629	40,565	54,036
1903	Bristol	800	434	50	61	1345	Duke of Beaufort	..	34,528	74,352	108,880
1904	Swansea	800	350	..	..	1150	Lord Windsor	..	28,265	50,562	78,827

NUAL EXHIBITIONS—*continued.*

Year.	Place Visited.	Local Subscription.	Prizes. Local Committee.	Prizes. Local Societies.	Prizes. Local Residents.	Total Local Contribution.	President.	Admissions. On 5/- Day.	Admissions. On 2/6 Days.	Admissions. On 1/- Days.	Admissions. Total.
		£	£	£	£	£					
1905	Nottingham .	800	..	218	..	1018	Duke of Portland, K.G. . .	..	8,913	45,964	54,877
1906	Swindon .	800	..	200	50	1050	Earl of Radnor . . .	..	7,838	42,013	49,851
1907	Newport (Mon.)	800	201	51	29	1081	H.R.H. The Prince of Wales, K.G.	..	16,236	37,819	54,055
1908	Dorchester .	800	100	25	..	925	Lord Digby . . .	..	12,227	20,350	32,577
1909	Exeter . .	800	..	100	..	900	Lord Clinton	..	14,898	41,891	56,789
1910	Rochester and Chatham .	800	117	..	..	917	Earl of Darnley . . .	..	5,892	20,105	25,997
1911	Cardiff . .	800	195	110	10	1115	Marquis of Bute . . .	..	16,213	40,588	56,801
1912	Bath . .	800	100	100	..	1000	Marquis of Bath . . .	..	13,843	40,935	54,788
1913	Truro . .	800	35	115	39	918	Viscount Falmouth . .	..	12,918	44,700	57,618
1914	Swansea .	800	301	...	..	1101	Sir J. T. D. Llewelyn, Bart. .	..	17,957	67,805	85,762
1915	Worcester .	400	..	257	..	657	The Earl of Coventry . .	..	7,760	28,013	35,773
1916	No Show.						The Earl of Coventry . .				
1917	ditto						The Earl of Coventry . .				

Members' Privileges.

ANALYSES OF FERTILISERS, FEEDING STUFFS, WATERS, SOILS, &c.

Applicable only to the case of Persons who are not commercially engaged in the manufacture or sale of any substance sent for Analysis).

Members of the Bath and West and Southern Counties Society, who may also be Members of other Agricultural Societies, are particularly requested in applying for Analyses, to state that they do so as Members of the first-named Society.

THE following are the rates of Charges for Chemical Analyses to Members of the Society.

These privileges are applicable only when the analyses are for *bona-fide* agricultural purposes, and are required by Members of the Society for their own use and guidance in respect of farms or land in their own occupation and within the United Kingdom

The analyses are given on the understanding that they are required for the individual and sole benefit of the Member applying for them, and must not be used for other persons, or for commercial purposes.

Land or estate agents, bailiffs, and others, when forwarding samples are required to state the names of those Members on whose behalf they apply.

Members are also allowed to send for analysis under these privileges any manures or feeding-stuffs to be used by their outgoing tenants, or which are to be given free of cost to their occupying tenants.

The analyses and reports may not be communicated to either vendor or manufacturer, except in cases of dispute.

Members are requested, when applying for an analysis, to quote the number in the subjoined schedule under which they wish it to be made.

No.		
1.	—An opinion of the purity of bone-dust or oil-cake (each sample)	2*s.* 6*d.*
2.	—An analysis of sulphate or muriate of ammonia, or of nitrate of soda, together with an opinion as to whether it be worth the price charged	5*s.*
3.	—An analysis of guano, showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts and ammonia, together with an opinion as to whether it be worth the price charged	10*s.*
4.	—An analysis of mineral superphosphate of lime for soluble phosphates only, together with an opinion as to whether it be worth the price charged	5*s.*
5.	—An analysis of superphosphate of lime, dissolved bones, &c., showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia, together with an opinion as to whether it be worth the price charged	10*s.*
6.	—An analysis of bone-dust, basic slag, or any other ordinary artificial manure, together with an opinion as to whether it be worth the price charged	10*s.*
7.	—An analysis of compound artificial manures, animal products, refuse substances used for manure, &c.	from 10*s.* to £1
8.	—An analysis of limestone, showing the proportion of lime	7*s.* 6*d.*
9.	—An analysis of limestone, showing the proportion of lime and magnesia ..	10*s.*
10.	—An analysis of limestone or marls, showing the proportion of carbonate, phosphate, and sulphate of lime and magnesia, with sand and clay	10*s.*
11.	—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime	£1
12.	—Complete analysis of a soil	£3
13.	—An analysis of oil-cake or other substance used for feeding purposes, showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre as well as of starch, gum, and sugar in the aggregate; and an opinion of its feeding and fattening or milk-producing properties..	10*s.*
14.	—Analysis of any vegetable product	10*s.*
15.	—Determination of the "hardness" of a sample of water before and after boiling	5*s.*
16.	—Analysis of water of land-drainage, and of water used for irrigation	£1
17.	—Analysis of water used for domestic purposes	£1 10*s.*
18.	—An analysis of milk (to assist Members in the management of their Dairies and Herds, *bona-fide* for their own information and not for trade purposes, nor for use in connection with the Sale of Food and Drugs Acts)	5*s.*
19.	—Personal consultation with the Consulting Chemist. (To prevent disappointment it is suggested that Members desiring to hold a consultation with the Consulting Chemist should write to make an appointment)	5*s.*
20.	—Consultation by letter	5*s.*
21.	—Consultation necessitating the writing of three or more letters	10*s.*

Members wishing to exercise their privileges on the above-named terms, should forward their samples for examination *by post or parcel prepaid*, to the Consulting Chemist, DR. JOHN AUGUSTUS VOELCKER, M.A., F.I.C., Stuart House, 1, Tudor Street, London, E.C.

The fees for analysis must be sent to the Consulting Chemist at the time of application.

GUIDE TO PURCHASERS OF FERTILISERS AND FEEDING STUFFS.

Purchasers are recommended in every case to insist upon having an *Invoice* given to them. This invoice should set out clearly :—

In the case of **Fertilisers**—
(1.) the **name** of the fertiliser ;
(2.) whether the fertiliser be artificially **compounded** or not ;
(3.) the **analysis** guaranteed in respect of the principal fertilising ingredients.

In the case of **Feeding-Stuffs**—
(1.) the **name** of the article ;
(2.) the **description** of the article ; whether it has been made from one substance or seed only, or from more than one
(3.) the **analysis** guaranteed in respect of Oil and Albuminoids.

(NOTE.—The use of the terms "Linseed-cake," "Cotton-cake," &c., implies that these cakes shall be "pure," and purchasers are recommended to insist upon these terms being used without any qualification such as "95 per cent.," "as imported," &c. "Oil-cake" should be avoided.

Members of the Society should see that the **Invoices** agree accurately with the orders given by them, and, in giving these orders, they should stipulate that the goods come up to the guarantees set out in the following list, and that they be **sold subject to the analysis and report of the Consulting Chemist of the Bath and West and Southern Counties Society.**

FERTILISERS.

Raw Bones, Bone-meal, or **Bone-dust** to be guaranteed "PURE," and to contain not less than 45 per cent. of Phosphate of Lime, and not less than 4 per cent. of Ammonia.

Steamed or "**Degelatinised**" **Bones** to be guaranteed "PURE," and to contain not less than 55 per cent. of Phosphate of Lime, and not less than 1 per cent. of Ammonia.

Mineral Superphosphate of Lime to be guaranteed to contain a certain percentage of "Soluble Phosphate." [From 25 to 28 per cent. of Soluble Phosphate is an ordinarily good quality.]

Dissolved Bones to be guaranteed to be "made from raw bone and acid only," and to be sold as containing stated percentages of Soluble Phosphate, Insoluble Phosphates, and Ammonia.

Compound Artificial Manures, Bone Manures, Bone Compounds, &c., to be sold by analysis stating the percentages of Soluble Phosphate, Insoluble Phosphates, and Ammonia contained.

Basic Slag to be guaranteed to contain a certain percentage of Phosphoric Acid, and to be sufficiently finely ground that 80 to 90 per cent. passes through a sieve having 10,000 meshes to the square inch.

Peruvian Guano to be described by that name, and to be sold by analysis stating the percentages of Phosphates and Ammonia.

Sulphate of Ammonia to be guaranteed to be "PURE," and to contain not less than 24 per cent. of Ammonia.

Nitrate of Soda to be guaranteed to be "PURE," and to contain 95 per cent. of Nitrate of Soda.

Kainit to be guaranteed to contain 23 per cent of Sulphate of Potash.

All fertilisers to be delivered in good and suitable condition for sowing.

FEEDING-STUFFS.

Linseed Cake, Cotton Cake (Decorticated and Undecorticated), and **Rape Cake** (for feeding purposes) to be pure, i.e., prepared *only* from one kind of seed from which their name is derived, and to be in sound condition. The report of the Consulting Chemist of the Bath and West and Southern Counties Society to be conclusive as to the "purity" or otherwise of any feeding-stuffs. The percentages of Oil and Albuminoids must also be guaranteed.

Mixed Feeding Cakes, Meals, &c., to be sold on a guaranteed analysis.

All Feeding-Stuffs to be sold in sound condition, and to contain nothing of an injurious nature or worthless for feeding purposes.

INSTRUCTIONS FOR SELECTING AND SENDING SAMPLES FOR ANALYSIS.

GENERAL RULES.

1.—A sample taken for analysis should be fairly *representative of the bulk* from which it has been drawn.

2. –The sample should reach the Analyst *in the same condition* as it was at the time when drawn.

FERTILISERS.

When **Fertilisers** are delivered in bags, select four or five of these from the bulk, and either turn them out on a floor and rapidly mix their contents, or else drive a shovel into each bag and draw out from as near the centre as possible a couple of shovelfuls of the manure, and mix these quickly on a floor.

Halve the heap obtained in either of these ways, take one-half (rejecting the other) and mix again rapidly, flattening down with the shovel any lumps that appear. Repeat this operation until at last only some three or four pounds are left.

From this fill three tins, holding from ½ lb. to 1 lb. each, mark, fasten up and seal each of these. Send one for analysis, and retain the others for reference.

Or,—the manure may be put into glass bottles provided with well-fitting corks; the bottles should be labelled and the corks sealed down. The sample sent for analysis can be packed in a wooden box and sent by post or rail.

When manures are delivered in bulk, portions should be successively drawn from *different parts* of the bulk, the heap being turned over now and again. The portions drawn should be thoroughly mixed, sub-divided, and, finally, samples should be taken as before, except that when the manure is coarse and bulky it is advisable to send larger samples than when it is in a finely-divided condition.

FEEDING-STUFFS.

Linseed, Cotton, and other Feeding Cakes.—If a single cake be taken three strips should be broken off right across the cake and from the middle portion of it, one piece to be sent for analysis, and the other two retained for reference. Each of the three pieces should be marked, wrapped in paper, fastened up and sealed. The piece forwarded for analysis can be sent by post or rail.

A more satisfactory plan is to select four to six cakes from different parts of the delivery, then break off a piece about four inches wide from the middle of each cake, and pass these pieces through a cake-breaker. The broken cake should then be well mixed, and three samples of about 1 lb. each should be taken and put in tins or bags duly marked, fastened, and sealed as before. One of these lots

should be sent for analysis, the remaining two being kept for reference. It is advisable, also, with the broken pieces, to send a small strip from an unbroken cake.

Feeding Meals, Grain, &c.—Handfuls should be drawn from the centre of half-a-dozen different bags of the delivery; these lots should then be well mixed, and three ¼ lb. tins or bags filled from the heap, each being marked, fastened up, and sealed. One sample is to be forwarded for analysis and the others retained for reference.

SOILS, WATERS, &c.

Soils.—Have a wooden box made, 6 inches in length and width, and from 9 to 12 inches deep, according to the depth of soil and subsoil of the field. Mark out in the field a space of about 12 inches square; dig round in a slanting direction a trench, so as to leave undisturbed a block of soil and its subsoil 9 to 12 inches deep; trim this block to make it fit into the wooden box, invert the open box over it, press down firmly, then pass a spade under the box and lift it up gently, turn over the box, nail on the lid, and send by rail. The soil will then be received in the position in which it is found in the field.

In the case of very light, sandy, and porous soils, the wooden box may be at once inverted over the soil and forced down by pressure, and then dug out.

Waters.—Samples of water are best sent in glass-stoppered Winchester bottles holding half a gallon. One such bottle is sufficient for a single sample. Care should be taken to have these scrupulously clean. In taking a sample of water for analysis it is advisable to reject the first portion drawn or pumped, so as to obtain a sample of the water when in ordinary flow. The bottle should be rinsed out with the water that is to be analysed, and it should be filled nearly to the top. The stopper should be secured with string, or be tied over with linen or soft leather. The sample can then be sent carefully packed either in a wooden box with sawdust, &c., or in a hamper with straw.

Milk.—A pint bottle should be sent in a wooden box.

GENERAL INSTRUCTIONS.

Time for Taking Samples.—All samples, both of fertilisers and feeding-stuffs, should be taken as soon after their delivery as possible, and should reach the Analyst within *ten days* after delivery of the article. In every case it is advisable that the Analyst's certificate be received before a fertiliser is sown or a feeding-stuff is given to stock.

Procedure in the event of the Vendor wishing Fresh Samples to be Drawn.—Should a purchaser find that the Analyst's certificate shows a fertiliser or feeding-stuff not to come up to the guarantee given him, he may inform the vendor of the result and complain accordingly. He should then send to the vendor *one* of the two samples which he has kept for reference. If, however, the vendor should demand that a fresh sample be drawn, the purchaser must allow this, and also give the vendor an opportunity of being present, either in person or through a representative whom he may appoint. In that case, three samples should be taken in the presence of both parties with the same precautions as before described, *each* of which should be duly packed up, labelled and *sealed* by both parties. One of these is to be given to the vendor, one is to be sent to the Analyst, and the third is to be kept by the purchaser for reference or future analysis if necessary.

All samples intended for the Consulting Chemist of the Society should be addressed (postage or carriage prepaid) to Dr. J. AUGUSTUS VOELCKER, M.A., F.I.C., Stuart House, 1, Tudor Street, New Bridge Street, London, E.C. Separate letters of instruction should be sent at the same time.

FINANCIAL STATEMENTS

FOR

1917

WITH ITEMS OF* 1916 *FOR COMPARISON.

The Bath and West and

DR. CASH ACCOUNT FOR THE YEAR ENDING DEC. 31ST,

RECEIPTS.	1917. £ s. d.	1917. £ s. d.	1916. £ s. d.
DIVIDENDS AND INTEREST :—			
War Loan Stock	200 5 4		131 17 6
South Australian Stock	31 1 10		32 12 10
New Zealand Stock	41 3 2		43 4 4
India Stock	169 12 4		178 2 0
Queensland Stock	82 10 10		86 13 4
New South Wales Stock	52 11 6		55 4 1
Canadian Pacific Stock	47 16 3		47 5 0
	625 1 3		574 19 1
Income Tax returned	184 11 8		204 3 3
		809 12 11	779 2 4
GENERAL RECEIPTS :—			
Telephone Way Leave, &c.		0 1 0	0 13 6
SUBSCRIPTIONS FROM MEMBERS :—			
Arrears	24 13 0		15 6 0
Governors	138 17 0		148 3 0
Subscribers of £1 and upwards	610 0 0		655 5 0
Ditto of 10*s*.	7 0 0		6 10 0
		780 10 0	825 4 0
LIFE COMPOSITIONS		5 0 0	
JOURNAL :—			
Sales (Current issue)	5 0 0		8 18 3
„ (Back volumes)			11 6 3
Advertisements	34 12 0		30 6 4
		39 12 0	45 10 10
Carried forward .		£ 1,634 15 11	

Southern Counties Society.

1917, WITH COMPARATIVE STATEMENT FOR 1916. CR.

PAYMENTS.	1917. £ s. d.	1917. £ s. d.	1916. £ s. d.
SALARIES:—			
Secretary (including Clerks, &c.)	1,050 0 0		1,050 0 0
Auditor	20 0 0		20 0 0
Consulting Chemist	30 0 0		30 0 0
		1,100 0 0	1,100 0 0
MISCELLANEOUS:—			
Printing	9 18 5		6 4 6
Stationery and Finance Books	14 6 8		21 5 1
Postages, Telegrams, Cheque and Receipt Stamps	12 18 4		16 0 11
Ground Rent and Rates	20 12 5		20 19 0
Property Tax	9 7 6		5 12 6
Travelling Expenses	16 3 10		12 16 2
Carriage of Goods	0 18 6		1 9 7
Directories and Reference Books	0 14 6		0 13 5
Subscriptions	6 11 0		6 11 0
Repairs and Fittings	3 4 8		5 12 10
Fuel and Light	6 13 6		4 18 9
Finance Committee's Expenses	3 6 0		4 14 6
Telephone	7 16 0		7 16 4
Bank Charges	2 4 11		3 3 5
Grants for Instruction in Milking	20 0 0		
Typewriter, &c.			4 12 6
Hire of London Rooms for Meetings			1 1 0
		140 16 3	123 11 6
JOURNAL:—			
Editor	100 0 0		100 0 0
Associate Editor	100 0 0		100 0 0
Printing and Binding	156 1 0		136 18 9
Plans and Blocks	21 14 6		9 13 0
Journal Distribution	18 19 11		20 15 2
Postages, Stationery, Reference Books, &c.	2 16 6		3 14 10
Payments to Authors	53 9 0		37 11 0
		453 0 11	408 12 9
Carried forward	£	1,693 17 2	

Dr. CASH ACCOUNT—*continued*

RECEIPTS.		1917.	1916.
	£ s. d.	£ s. d.	£ s. d.
Brought forward .		1,634 15 11	
		1,634 15 11	1,650 10 8
Balance due to Bank, Dec. 31st . .		618 6 11	269 13 2
		£ 2,253 2 10	1,920 3 10

CASH ACCOUNT—*continued.* Cr.

PAYMENTS.	1917.		1916.
	£ s. d.	£ s. d.	£ s. d.
Brought forward .		1,693 17 2	
SHOW:—			
Deferred Prizes for Stock			7 0 0
Unapportionable:—			
Superintendent of Works	150 0 0		150 0 0
Insurance of Plant	1 15 0		1 15 0
Rent of Stores	7 17 6		
		159 12 6	151 15 0
EXPERIMENTS:—			
Cider Institute		100 0 0	100 0 0
		1,953 9 8	1,890 19 3
INVESTMENTS		30 0 0	12 8 3
Balance due to Bank, Jan. 1st . .		269 13 2	16 16 4
	£	2,253 2 10	1,920 3 10

Jan. 19th, 1918.

I hereby certify that I have examined the foregoing accounts for the year ending December 31st, 1917, compared the payments entered with the vouchers, and found them all in order and correct.

F. CLIFFORD GOODMAN, F.C.A.,
Auditor.

Passed by Council,
Jan. 29th, 1918,

THOS. F. PLOWMAN,
Secretary.

ASSETS AND LIABILITIES ACCOUNT TO DECEMBER 31ST, 1917, WITH COMPARISON FOR 1916.

ASSETS.

	Par. Value. £ s. d.	Actual Cost £ s. d.	Market Value on Dec. 31. £ s. d.		1917. £ s. d.	1916. £ s. d.
INVESTMENTS					14,984 7 4	15,069 15 10
New Zealand Stock	1,568 1 6	1,500 0 0	1,129 0 1			
War Loan Stock	4,099 11 1	5,809 19 6	3,843 6 8			
Ditto to replace capital lost by conversion	44 14 10	42 8 3	41 18 10			
India Stock	7,538 15 1	7,277 5 1	4,108 12 5			
Queensland "	2,751 9 0	3,000 0 0	2,448 15 9			
N. S. Wales "	1,752 8 10	2,000 0 0	1,419 9 6			
Canadian Pacific Rly. "	1,500 0 0	1,576 2 6	1,185 0 0			
South Australian "	1,036 3 3	1,000 0 0	808 4 1			
	20,291 3 7	22,205 15 4	14,984 7 4			
FUND FOR REPLACEMENT OF CAPITAL					31 1 7	30 0 0
INCOME TAX RECOVERABLE					73 11 8	114 5 6
PLANT:— Works				167 1 7		185 12 10
Dairy				13 15 1		15 5 7
					180 16 8	200 18 5
HOUSE PROPERTY				633 10 7		633 10 7
FURNITURE AND FITTINGS				157 19 5		162 0 5
					791 10 0	795 11 0
SUBSCRIPTION ARREARS					136 2 0	94 18 0
					£ 16,197 9 3	16,305 8 9

LIABILITIES.

	1917. £ s. d.	1916. £ s. d.
JOURNAL, cost of, estimated at	450 0 0	450 0 0
DUE TO BANK	618 6 11	269 13 2
DUE TO FUND FOR REPLACEMENT OF CAPITAL	31 1 7	30 0 0
	1,099 8 6	749 13 2
BALANCE	15,098 0 9	15,555 15 7
	£ 16,197 9 3	16,305 8 9

January 19th, 1918.
I hereby certify that I have audited the above Balance Sheet, and that, in my opinion, it is correct, and shows the true position of the Society's affairs according to the Books. The securities for the Society's Investments have been produced to me, and I have found them in order. The various Stocks have been valued by the Society's Bankers.

F. CLIFFORD GOODMAN, F.C.A., Auditor.

Passed by Council
January 29th, 1918.
THOS. F. PLOWMAN, Secretary.

Bath and West and Southern Counties Society,

FOR THE

Encouragement of Agriculture, Arts, Manufactures and Commerce.

List of Members, 1918.

PATRON.

HIS MOST GRACIOUS MAJESTY THE KING.

PRESIDENT.

THE RIGHT HON. THE EARL OF COVENTRY.

TRUSTEES.

THE MOST HON. THE MARQUIS OF BATH, K.G.
SIR C. T. D. ACLAND, BART.
C. L. F. EDWARDS, ESQ.

Names thus (*) distinguished are Governors.
Names thus (†) distinguished are Life Members.
⁂ *Members are particularly requested to make the Secretary acquainted with any errors in the names of residences.*

Name.	Residence.	Subscriptions. £	s.	d.
*†His Most Gracious Majesty the King	Windsor Castle		..	
Ackers, Chas. P.	Huntley Manor, Gloucester	1	0	0
Ackland, J.	Cutton Farm, Poltimore, Exeter	1	0	0
Acland, Alfred Dyke	. . . .	1	0	0
†Acland, Rt. Hon. A. H. Dyke	29, St. James' Court, Buckingham Gate, London, S.W.1		..	
*Acland, Sir C. T. D., Bart.	Killerton, Exeter	5	0	0
Acland, Right Hon. F. Dyke, M.P.	93, Bedford Gardens, Campden hill, London, W.	1	0	0
Adams, E. C.	Brentwood, Combe Down, Bath	1	0	0
Adams, G. & Son	Wadley House, Faringdon, Berks	1	0	0
Adeane, C. R. W.	Babraham, Cambridge	1	0	0
†Aitken, G. H.	Longleat Estate Office, Warminster		..	
Akers, E.	St. Fagans, Cardiff	1	0	0
Alexander, D.	Cardiff	1	1	0
Alexander, H. G.	Dinas Powis, Cardiff	1	1	0

Name.	Residence.	Sub-scriptions. £	s.	d.
Allen & Sons	Cheese Merchants, Shepton Mallet	1	1	0
†Allen, James D.	Springfield House, Shepton Mallet		..	
Allen, W. T.	West Bradley, Glastonbury	1	0	0
Allix, C. I. L.	St. Germans, Cornwall	1	0	0
Allsebrook, A.	Link Elm, Malvern Link	1	1	0
Ames, F.	Hawford Lodge, Worcester	1	0	0
Andrews, S. Fox-	Union Street, Bath	1	0	0
Anglo-Continental Guano Works	Dock House, Billiter Street, E.C.3.	1	0	0
Anglo-Swiss Condensed Milk Company	Chippenham	1	0	0
Arnott, G. C. (Fertilisers Manufacturers Association)	69, Fenchurch Street, London, E.C.3	1	0	0
†Ashcomb, Lord	Denbies, Dorking		..	
†Ashcroft, W.	13, The Waldrons, Croydon		..	
Ashford, E. C., M.D.	The Moorlands, Bath	1	0	0
*Astor, Hon. Waldorf	Cliveden, Taplow, Bucks	2	0	0
Augustein, J. R.	Holbrook House, Wincanton	1	0	0
Aungier, J.	Lynwick, Rudgwick	1	0	0
†Avebury, Lord	High Elms, Hayes, Kent		..	
†Aveling, Thomas L.	Rochester		..	
Avon Manure Company (Ld.)	St. Philip's Marsh, Bristol	1	0	0
Badcock, H. Jefferies	Broadlands, Taunton	1	0	0
Bainbridge, Mrs. R. C.	Elfordleigh, Plympton, South Devon	1	0	0
Baker, G. E. Lloyd	Hardwicke Court, Gloucester	1	0	0
†Baker, M. G. Lloyd	The Cottage, Hardwicke, Glos.		..	
†Baker, L. J.	10, Ennismore Gardens, London, S.W.7		..	
*Balston, W. E.	Barvin, Potters Bar, Herts	2	0	0
Bamfords (Ltd.)	Uttoxeter	1	1	0
Barford and Perkins (Ltd.)	Peterborough	1	0	0
Barham, G. T.	Sudbury Park, Wembley, Middlesex	1	0	0
Baring, Hon. A. H.	The Grange, Alresford, Hants	1	0	0
*Barker-Hahlo, H.	Camerton Court, Bath	2	0	0
Barlow, Sir J. Emmott, Bart., M.P.	Torkington Lodge, Hazel Grove, near Stockport	1	0	0
Barrett, Col. W.	Hill House, Minehead	1	0	0
Barstow, J. J. J.	The Lodge, Weston-super-Mare	1	1	0
Barton, D. J.	Penbertha, Marazion, Cornwall	0	10	0
Bassett, A. F.	Tehidy, Camborne, Cornwall	1	0	0
Bates, W. J. & Co.	Victoria Iron Works, Denton, Manchester	1	0	0
*†Bath, Marquis of, K.G.	Longleat, Warminster		..	
Bath and Somersetshire Dairy Co. (Ltd.)	Bath	1	0	0

Name.	Residence.	£	s.	d.
Bath and Wells, The Bishop of	The Palace, Wells	1	1	0
Bath Gas Company	Bath	1	0	0
†Bathurst, Capt. Sir C., M.P.	Lydney Park, Glos.		..	
Batt, R.	Clapton, Ston Easton, Bath	1	0	0
Batten, Col. Cary	Abbotsleigh, Bristol	1	0	0
Batten-Pooll, R. H.	Road Manor, Bath	1	0	0
†Baxendale, J. Noel	Froxfield Green, Petersfield		..	
Bayly, J.	Highlands, Ivybridge, S. Devon	1	0	0
Beauchamp, E. B.	Trevince, Redruth	1	0	0
Beauchamp, F. B.	Woodborough House, Peasedown St. John, Bath	1	1	0
*Beaufort, Duke of	Badminton, Chippenham	2	2	0
Beaufoy, M. H.	Coombe Priory, Shaftesbury	1	0	0
Bennett, Brothers	*Journal* Office, Salisbury	1	1	0
Bennett, R. A.	Thornbury, Glos.	1	0	0
Bennetts, J. M.	Killaganoon, St. Feock, Cornwall	1	1	0
Bentall, Edward H. & Co.	Heybridge, Maldon, Essex	1	0	0
B^nyon, H. A.	Englefield House, Reading	1	1	0
*Benyon, J. Herbert	Englefield House, Reading	5	0	0
Berryman, F. H.	Field House, Shepton Mallet	1	1	0
Best, Major T. G.	East Carleton Manor, Norwich	1	0	0
†Best, Capt. W.	Vivod, Llangollen, North Wales		..	
Best, Hon. Bertha	Charlton House, Ludwell, Salisbury	1	0	0
Best, Hon. J. W.	Charlton House, Ludwell, Salisbury	1	0	0
Beynon, J. W.	16, Mount Stuart Square, Cardiff	1	1	0
Birmingham, C.	Nutscale, The Parks, Minehead	0	10	0
†Blackburn, H. P.	Donhead Hall, Salisbury		..	
†Blackstone, G. M.	Blackstone & Co., Ld., Stamford		..	
Blake, Col. M. Lock	Bridge, S. Petherton	1	0	0
Blathwayt, R. W.	Dyrham Park, Chippenham	1	1	0
Board, R. J.	Skinner, Board & Co., Rupert St., Bristol	1	0	0
Bolden, Rev. C.	Preston Bissett, Buckingham	1	0	0
Bolitho, R. F.	Ponsandane, Penzance	1	1	0
Bolitho, T. R.	Trengwainton, Hea Moor, Cornwall	1	1	0
Bond E. (W. Evans & Co.).	Hele, Cullompton	1	0	0
Boscawen, Rev. A. T.	Ludgvan Rectory, Long Rock, R.S.O., Cornwall	1	0	0
Boscawen, Townshend E.	2, Old Burlington St., London, W.1.	1	0	0
Bourne, W. W.	Garston Manor, Watford, Herts	1	0	0
Bouverie, H. P.	Brymore, Bridgwater	1	0	0
†Bowen-Jones, Sir J., Bart.	The Woodlands, Bicton, near Shrewsbury		..	
†Bowerman, Alfred	Hewelsfield Court, St. Briavels, Glos.		..	
Boyle, Capt. M.	The Manor, Staple Fitzpaine, Taunton	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Braby, F. & Co.	Ashton Gate Works, Bristol	1	0	0
Bradford, Thomas & Co.	Salford, Manchester	1	0	0
*†Brassey, H. L. C.	Apethorpe Hall, Wansford, Northants	..		
Bridges, J. H.	Ewell Court, near Epsom	1	1	0
†Brinkley, Rev. W. F. B.	The Vicarage, Abbots Leigh, Bristol	..		
Bristol Times and Mirror, Proprietors of	Bristol	1	0	0
Bristol Wagon and Carriage Works Co. (Ltd.)	Lawrence Hill, Bristol	1	1	0
Britten, Forester	Kenswick Manor, Worcester	1	0	0
†Broadmead, W. B.	Enmore Park, Bridgwater	..		
†Brocklehurst, H. D..	Sudeley Castle, Winchcombe	..		
Brockman, F. D.		1	0	0
Broderip, E.	Cossington, Somerset	1	0	0
Brown, F. E.	1,403 Neath Road, Swansea	1	0	0
Browning, Albert, M.A.	The Homestead, Combe Park, Bath	1	1	0
†Buckingham, Rev. Preb.	The Rectory, Doddiscombsleigh, Exeter, Devon	..		
Buck, D.	White House, Little Mill, Pontypool	1	0	0
Budd, Felix S.	Clarendon House, Stow Park, Newport, Mon.	1	0	0
Budd, J. E.	Tidebrook Manor, Wadhurst, Sussex	1	0	0
Burghclere, Lord	48, Charles Street, London, W.	1	0	0
Burnard, R.	Cattedown, Plymouth	1	0	0
Burrell, C. and Sons	St. Nicholas Works, Thetford	1	0	0
*Burrell, Sir M. R., Bart.	Knepp Castle, Horsham, Sussex	2	0	0
†Bush, H. G.	The Grove, Alveston, Glos.	..		
Bush, Mrs. L. E.	St. Mary's, Atlantic Road South, Weston-s-Mare	1	1	0
Busk, H. G.	Bransford, Worcester	1	1	0
Buswell, C. and W.	Torquay	1	0	0
*Bute, The Marquis of	The Castle, Cardiff	2	0	0
Butland, B.	Leigham, Plympton	1	0	0
Butler, I.	Bryn Corner, Pontrhyclyrun, near Newport, Mon.	1	0	0
Byng, Col. Hon. C.	Cavalry Club, 127, Piccadilly, London, W.1.	1	1	0
Cæsar, H. and J.	Knutsford, Cheshire	1	0	0
Calthrop Bros. (Ld.)	56, Naylor Street, Liverpool	1	0	0
Campbell, J.	93, Mansel Street, Swansea	1	0	0
Candy, T. C.	Woolcombe, Cattistock, Dorset	1	0	0
Carew, C.	Collipriest, Tiverton	1	0	0
Carnarvon, Earl of	Highclere Castle, Newbury	1	1	0

Name.	Residence.	£	s.	d.
*Carr, Jonathan	Wood House, Twerton-on-Avon, Bath	2	2	0
†Carruthers W., F.R.S.	14, Vermont Road, Norwood, London, S.E.		..	
Carson, J.	Crystalbrook, Theydon Bois, Essex	1	0	0
†Carter, E.	East Upton, Ryde, Isle of Wight		..	
Carter, G. V.	Waterston Manor, Dorchester	1	1	0
Carter, Dunnett & Beale	Raynes Park, London, S.W.	1	0	0
Cartwright, T. G.	30, Beaufort Gardens, London, S.W.	1	0	0
Carver, H. R.	West House, Chilton Polden, Bridgwater	1	0	0
Cary, Edmund	Pylle, Shepton Mallet	0	10	0
†Cary, John	The Priory, Shepton Mallet		..	
†Cary, W. H.	Mantua, Steeple Ashton, Trowbridge		..	
Cattybrook Brick Co. (Ltd.)	Provident Buildings, 15, Clare Street, Bristol	1	0	0
Cave, Sir C., Bart.	Lidbury Manor, Sidmouth	1	0	0
Cave, C. H.	Rodway Hill House, Mangotsfield, Bristol	1	0	0
Cazalet, W. M.	Fairlawne, Tonbridge	1	0	0
Chapman, W. W.	Mowbray House, Norfolk Street, Strand, London, W.C.2	1	1	0
Chichester, Major C. H.	Hall, Bishops Tawton, Barnstaple	1	0	0
†Chick, J. H.	Wynford Eagle, Maiden Newton, Dorset		..	
†Chick, W. D.	Compton Valence, Dorchester		..	
Childs, C., M.D.	Boscarn, Looe, R.S.O., Cornwall	1	0	0
Christie, A. L.	Tapeley Park, Instow, N. Devon	1	1	0
Churchill, The Viscount, G.C.V.O.	Carlton Club, Pall Mall, London, S.W.1.	1	0	0
†Churchward, F.	Hill House, Stoke Gabriel, near Totnes		..	
*Clarendon, Earl of	The Grove, Watford	2	2	0
Clark, H. A.	Hinton Field, Hinton Charterhouse, Bath	1	0	0
†Clark, J. J.	Goldstone Farm, Hove, Sussex (Hon. Local Sec., 1885)		..	
Clark, W. S.	Street, Glastonbury	1	0	0
Clark, W. H.	Rutland Cottage, Combe Down, Bath	1	1	0
Clarke, J. B.	Overleigh House, Street, Somerset	1	0	0
Clerk, Lieut.-Col. R. M.	Charlton House. Shepton Mallet	1	0	0
*Clifden, Viscount	Lanhydroc, Bodmin	2	0	0
Clinton, Lord	Heanton Satchville, Dolton, N. Devon	1	0	0
Clutton, R. W.	Hartswood, Reigate	1	0	0
Coaker, J.	Blagdon Barton, Paignton, Devon	1	0	0

Name.	Residence.	£	s.	d.
Cobb, H. M.	Higham, Rochester	1	0	0
Cobb, R.	Larkin Hall, near Rochester	1	0	0
Coleridge, Hon. G.	Toddington, Winchcombe	1	0	0
Collins, J. J. S.	St. George's Lodge, Oldfield Park, Bath	1	1	0
Colman, Sir J., Bart.	Gatton Park, Surrey	1	0	0
Colmer, Jas. (Ltd.)	Union Street, Bath	1	0	0
Colthurst, Symons & Co. (Ltd.)	Bridgwater	1	0	0
Colville, H. K.	Hillmarton Lodge, Calne, Wilts	1	0	0
Cook, R.	Widhayes, Tiverton	1	0	0
†Cookson, H. T.	Sturford Mead, Warminster	..		
Cooling, G. and Sons	Northgate Street, Bath	1	1	0
Cooper, Sir G., Bart.	Hursley Park, Winchester	1	0	0
Cope, W.	Southerndown, Glam.	1	1	0
Corbet, E. W. M.	Bute Estate Office, Cardiff	1	1	0
Corbett, Thomas	Perseverance Iron Works, Shrewsbury	1	0	0
Corker & Bevan	Swansea	1	1	0
†Cork and Orrery, The Earl of	Marston, Frome	..		
†Corner, H. W.	Manor House, Inglescombe, Bath	..		
†Cornwallis, F. S. W.	Linton Park, Maidstone	..		
Cory, Sir Clifford, Bart., M.P., D.L.	Llantarnam Abbey, Mon.	1	0	0
Cory, E.	London, Gloucester and N. Hants Dairy Co. (Ltd.), Whatley Road, Clifton, Bristol	1	0	0
Cottam, H. C. D.	The Old Rectory, Wilton, near Salisbury	1	0	0
†Cotterell, Sir J. R. G., Bart.	Garnons, Hereford	..		
Coultas, J. R.	Allington, near Grantham	1	0	0
Coultrip, A. W.	Norwood Manor, East Church, Kent	1	0	0
†Courage, Raymond	Shenfield Place, Brentwood, Essex	..		
†Coussmaker, Lt.-Col. G.	Westwood, Normandy, Guildford, Surrey	..		
*Coventry, The Earl of	Croome Court, Worcester	2	0	0
Cox, B.	Pwlpen Farm, Christchurch, Newport, Mon.	0	10	0
Cox & Sons	47, City Road, Cardiff	1	0	0
Crewdson, J. D.	Syde, near Cheltenham	1	0	0
Crick, Thomas	Great Ash, Winsford, Dulverton	0	10	0
Cridlan, J. J.	Maisemore Park, Gloucester	1	0	0
Crutchley, P. E.	Limminghill Lodge, Ascot	1	0	0
Cuming, A. P.	Moreton Hampstead, Devon	1	0	0
Cundall, H. M., I.S.O., F.S.A.	Richmond Hill, Surrey	1	0	0
†Curre, E.	Itton Court, Chepstow	..		
Currie, L.	Minley Manor, Farnborough, Hants	1	0	0

Name.	Residence.	£	s.	d.
Dairy Supply Company (Ltd.)	Museum St., Bloomsbury, London, W.C.9	1	0	0
†Daniel, H. T.	The Red House, Cannington, Bridgwater		..	
Daniel, Thos. C.	Stuckeridge, Bampton, North Devon	1	1	0
Darby, A. E. W.	Little Ness, Shrewsbury	1	0	0
Darby, E.	Liscombe, Dulverton	1	0	0
†Darell, D.	Hillfield House, Stoke Fleming, near Dartmouth		..	
†Davenport, Rev. Geo. H.	Foxley, Hereford		..	
†Davey, J. Sydney	Brockym, Cury - Cross - Lanes, Cornwall		..	
Davey, Sleep, & Co. (Ltd.)	Excelsior Plough Works, Plymouth	1	0	0
David & David	Old Bank Chambers, 27, High Street, Cardiff	1	0	0
Davies, D.	The Borough Stores, College Street, Swansea	1	1	0
Davis, F. L.	7, Bute Crescent, Cardiff	1	1	0
†Davis, H. J.	Sutton Montis, Sparkford, S.O., Somerset		..	
Davis & Co.	75, George Street, Oxford	1	0	0
Daw, J. E.	Exeter	1	1	0
Day and Sons (Ltd.)	Crewe	1	0	0
†Deacon, W. S.	Poynters, Cobham, Surrey		..	
De Bertodano, B.	Cowbridge House, Malmesbury	1	0	0
De Blaquiere, Lord	3, The Circus, Bath	1	0	0
De Hamel, E.	Middleton Hall, Tamworth	1	0	0
Demuth, R. H.	. . . .	1	0	0
Dening, C. & Co.	Chard, Somerset	1	0	0
Dennis, S.	Latton, Cricklade, Wilts	1	0	0
Denny, G. A.	. . . .	1	0	0
†Devas, H. G.	Hartfield, Hayes, Kent		..	
*Devon, The Earl of	Powderham Castle, Devon	2	0	0
*Devonshire, Duke of	Chatsworth, Derbyshire	5	0	0
Dew, W. S.	Newton St. Loe, Bristol	1	0	0
Dickson and Robinson	Cathedral Street, Manchester	1	1	0
Dickson's (Ltd.)	Chester	1	1	0
†Digby, Lord	Minterne, Cerne Abbas		..	
Digby, F. J. B. Wingfield	Sherborne	1	0	0
†Dobson, H. V.	Perridge House, Shepton Mallet		..	
Dodington, R. M.	Horsington Park, Templecombe	1	1	0
Donati, A. W.	Estate Office, Holnicote, Taunton	1	0	0
Dormer, Capt. C. W. C.	Rousham, Oxford	1	0	0
Drummond, Col. F. D. W.	Cawdor Estate Office, Carmarthen	1	0	0
Drummond, H. W.	Board Room, L. & S.W.R., Waterloo Station, London	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Duchesne M. C.	Farnham Common, Slough, Bucks.	1	0	0
*Ducie, Earl of	Tortworth Court, Falfield, R.S.O., Glos.	2	0	0
Dugdale, J. M.	Llwyn, Llanfyllin, near Oswestry	1	0	0
†Dunboyne, Lord	Greendale, Clyst St. Mary, Exeter	..		
Duncan, R.	Rhoose, near Barry	1	0	0
Dunlop, I. M.	Avonhurst, Sneyd Park, Bristol	1	0	0
*Dyke, Rt. Hon. Sir W. Hart, Bart.	Lullingston Castle, Eynsford	2	2	0
Eagle Range and Gas Stove Company (Ltd.)	Catherine Street, Aston, Birmingham	1	0	0
Eastwood, A. C.	Leigh Court, Taunton	1	0	0
*†Eastwood, J. E.	Gosden House, Bramley, Guildford	..		
Economic Fencing Company (Ltd.)	Billiter House, Billiter Street, London, E.C.3	1	0	0
Eden, R. H. H.	Sherborne, Dorset	1	0	0
†Edgcumbe, Sir Robert Pearce		..		
†Edmondson, A.	Woodclose, Silverdale, Lancashire	..		
Edwards, A. P.	Gogs House, Wedmore, Somerset	1	1	0
Edwards, C. L. Fry	The Court, Axbridge, Somerset	1	0	0
Edwards, W. H. G.	Butcombe Court, Wrington	1	0	0
Eldridge, Pope & Co.	Dorchester	1	0	0
Elliott, T. M.	Biddestone, Chippenham	1	0	0
Elton, B. A.	Clevedon Court, Somerset	1	0	0
*Elton, Sir E., Bart.	Clevedon Court, Clevedon	2	2	0
Enderby, Miss E. M.	Beckington, Bath	1	1	0
Enfield, Viscount	Dancer's Hill, Barnet	1	0	0
Ensor, T. & Sons	Auctioneers, Dorchester	1	0	0
Errington, R.	Victoria Mills, Sunderland	1	0	0
Esdaile, C. E. T.	Cothelstone House, Taunton	1	0	0
Evans, H. M. Glynn	Plasissa, Llangennech, Carmarthenshire	1	0	0
Evans, H. R.	Court of Noke, Pembridge, Herefordshire	1	0	0
†Evan-Thomas, Commander A.	Caerwnon, Builth Wells, R.S.O.	..		
†Eve, Mr. Justice	Pullabrook, Bovey Tracy, South Devon	..		
Evelyn, Mrs.	Wotton House, nr. Dorking	1	0	0

Name.	Residence.	£	s.	d.
*Falmouth, Viscount	Tregothnan, Truro	2	0	0
Faringdon, Lord	Buscot Park, Faringdon	1	1	0
†Farmer, S. W.	Little Bedwyn, Wilts		..	
†Farwell, Capt. E. W.	Queen's Parade, Bath		..	
Fastnut (Ltd.)	115, Newgate Street, London	1	1	0
Faudel-Phillips, H.	Mapleton Stud, Edenbridge, Kent	1	0	0
Fenton, A. D.	Maristow, Roborough, S. Devon	0	10	0
Ferrand, G. F.	Morland Hall, Alton, Hants	1	0	0
Finlay, Col. Alexander	Little Brickhill, Bletchley, Bucks	1	0	0
Finn, L. & G.	Westwood Court, Faversham	1	0	0
*Fitzgerald, Sir M., Bart., (Knight of Kerry)	Buckland, Faringdon, Berks.	2	0	0
Fleming, J. Willis	Stoneham Park, Eastleigh, Hants	1	0	0
†Fletcher, Lionel J. W.	West Farleigh, Maidstone		..	
Flower, James	Chilmark, Salisbury	1	0	0
*†Forester, Capt. F. W.	Saxilbye Park, Melton Mowbray		..	
Forrest, Col. W.	St. Fagan's, Cardiff	1	0	0
Forster, J. C.	Clatford Mills, Andover	1	0	0
†Fortescue, J. B.	Boconnoc, Lostwithiel, Cornwall		..	
Foster-Harter, G. L.	Salperton Park, Compton Abdale, R.S.O., Glos.	1	0	0
Four Oaks Spraying Machine Co. (Ltd.)	Four Oaks Works, Sutton Coldfield	1	0	0
Fowler & de la Perrelle	Porter's Lane, Southampton	1	0	0
Fowler, J. & Co. (Ltd.)	Leeds	1	0	0
Fox, Brothers & Co.	Wellington, Somerset	1	1	0
Fox, C. L.	Rumwell Hall, Taunton	1	0	0
Fox, Mrs. A.	Brislington House, near Bristol	1	0	0
†Fox, Robert	Grove Hill, Falmouth		..	
Fox, R. A.	Yate House, Yate, Glos.	1	1	0
Foxcroft, C. T.	Hinton Charterhouse, Bath	1	1	0
*Fremlin, W. T.	Milgate Park, Maidstone	2	0	0
Fry, A. M.	8, Zion Hill, Clifton, Bristol	1	0	0
Fry, H. A.	19, Monmouth Place, Bath	1	1	0
*Fry, F. J.	Cricket St. Thomas, Chard	2	0	0
*Fry, J. S. & Sons (Ltd.)	Union Street, Bristol	2	2	0
†Fuller, G. Pargiter	Neston Park, Corsham		..	
Fuller, S. and A.	Bath	1	0	0
Fursdon, E. S.	Hevers, Mont le Grand, Heavitree, Exeter	1	1	0
Gardiner, Sons & Co.	Nelson Street, Bristol	1	1	0
Garne, W.	Aldsworth, Northleach	1	1	0
Garne, W. T.	Aldsworth, Northleach	1	1	0
*Garratt, Lt.-Col. T. A. T.	Bishop's Court, Exeter	2	2	0
Garrett, W.	Backwell Hill House, West Town, R.S.O., Somerset	1	0	0

Name.	Residence.	£	s.	d.
Garton, Jas. . . .	Clarendon Park, Salisbury . .	1	0	0
Gear, W. H. . . .	Bridge Street, Bath . . .	1	1	0
*†George, William E., J.P.	Downside, Stoke Bishop, Bristol		..	
Gibbins, T. . . .	Glynfelin, Neath . . .	1	1	0
†Gibbons, H. . . .	Church Farm, Clutton, Bristol .		..	
Gibbons, P., J.P. . .	Keynsham	1	1	0
Gibbs, Major A. H. . .	11, Marlborough Buildings, Bath .	1	0	0
*†Gibbs, G. A., M.P. . .	Tyntesfield, Bristol . . .		..	
†Gibbs, H. M. . . .	Barrow Court, Flax Bourton, Bristol		..	
Gibson, J. T. . . .	Warren House, Wrington . .	1	1	0
Gill, P. O. . . .	Uplands, Wrington, Somerset .	1	0	0
Gillingham, J. and Son .	Prospect House, Chard . .	1	1	0
†Gladstone, J. . . .	Bowden Park, Chippenham . .		..	
Glencross, T. . . .	The Loose Box, Weston-super-Mare	1	0	0
Glyn, R. F. . . .	The Cross House, Fontmell Magna, Shaftesbury	1	0	0
*Glyn, Sir Richard G., Bart.	Gaunt's House, Wimborne . .	2	2	0
†Godman, C. B. . .	Woldringfold, Horsham . .		..	
Godman, J. . . .	The Raswells, Hascombe, Godalming	1	0	0
†Goldney, Sir Prior, Bart., C.B.	Derriads, Chippenham . . .		..	
Gomer, W. . . .	Killerton Estate Office, Broadclyst, Exeter	1	0	0
Goodden, J. R. P. . .	Compton House, Sherborne . .	1	0	0
Goodman, A. & Co. . .	3, Hammett Street, Taunton, and Broad Street House, London, E.C.	1	0	0
Gordon, G. H. . . .	The Barn House, Sherborne .	1	0	0
Goring, C. . . .	Wiston Park, Steyning . . .	1	0	0
†Gorringe, Hugh . .	Kingston-by-Sea, Brighton . .		..	
Grace, A.	39, Welsh Back, Bristol . .	1	0	0
Grant, C. E. . . .	Bursar, King's College, Cambridge.	1	0	0
Grant, W. J. . . .	Pentonville, Newport, Mon. . .	1	0	0
Gray, R.	The Estate Office, Sherborne .	1	0	0
Greaves, R. M. . . .	Wern, Portmadoc, North Wales .	1	0	0
†Greenall, Mrs. C. E. . .	The Manor, Carlton Scroop, Grantham		..	
†Greenall, Sir G., Bart. .	Walton Hall, Warrington . .		..	
Greenslade, W. R. J. . .	Fairfield, Trull, Taunton . .	1	0	0
Greenway, W. . . .	Halse, Taunton	1	0	0
Greenwell, Sir W., Bart. .	Marden Park, Woldingham, Surrey	1	0	0
Greenwood, J. C. . .	Claverton Down, Bath . .	1	0	0
Gregor, T. . . .	11, Sketty Road, Swansea . .	1	0	0
Gregory, W. . . .	Wellington, Somerset . . .	1	0	0
†Guest, Lady Theodora .	Inwood, Templecombe. . .		..	
Guille, H. C. de Stevens .	St. George, Castel, Guernsey .	1	0	0
Guise, Sir W. F., Bart. .	Elmore Court, Gloucester . .	1	0	0
Gunther, C. E. . .	Tongswood, Hawkhurst, Kent .	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Habgood, G.	Harley Lodge, Wimborne	1	0	0
Hall, A. C.	The Manor, Great Rolbright, Chipping Norton	1	0	0
*Hambleden, Viscount	Greenlands, Henley-on-Thames	5	0	0
†Hambro, Sir Everard A.	Hayes Place, Beckenham, Kent	..		
Hancock, Rev. Prebendary F.	The Priory, Dunster, Somerset	1	0	0
Hancock, H. C.	The Court, Milverton, Taunton	1	0	0
Hancock, Mrs. R. D.	Halse, Taunton	1	0	0
Harbottle, E.	Topsham	1	0	0
Harding, C.	Upton Grove, Tetbury	1	0	0
Harpur, W.	Borough Engineer, Cardiff	1	0	0
Harris, C. & T. (Ltd.).	Bacon Curers, Calne, Wilts	1	0	0
Harris, H.	Singleton Park Farm, Sketty, S.O., Glam.	1	0	0
Harris, J. M.	Chilvester Lodge, Calne, Wilts	1	0	0
Harrison, D.	The Grove, Tenby	1	0	0
Harrison, McGregor & Co.	Leigh, Lancashire	1	0	0
Haward, T. W..	Manor End, Berkhamsted, Herts	1	1	0
Hawkins, A. W. Bailey	Stagenhoe Park, Welwyn, Herts	1	0	0
†Haydon, Lt.-Col. W. H.	Maidford, Malmesbury, Wilts	..		
Hayes, F. J.	West Pennard, Glastonbury	1	0	0
Heathcoat-Amory, Sir I. M., Bart.	Hensleigh, Tiverton, Devon	1	0	0
†Henderson, A. N.	Street Ashton House, Lutterworth	..		
Heneage, Capt. R.N.	Parc le Breos, Penmaen, Glam.	1	0	0
Henry, Lt.-Col. F.	Elmstree, Tetbury	1	0	0
Heppel, E. M.	Camerton, near Bath	1	0	0
Herbert, Maj.-Gen. Sir Ivor, Bart., M.P.	Llanarth Court, Raglan, Mon.	1	0	0
Hesse, F. W.	Bloomfield House, Bloomfield Road, Bath	1	0	0
†Hewitt, G. Southby.	Day, Son & Hewitt, 22, Dorset Street, London, W.1	..		
Higgins, B.	Millhouse Farm, Evercreech	0	10	0
†Hill, B. H.	Uphill, Weston-super-Mare	..		
Hill, H.	Paulton, near Bristol	1	1	0
Hill, Capt. V. T.	Mendip Lodge, Langford, Bristol	1	1	0
Hippisley & Sons	Wells, Somerset	1	0	0
Hippisley, R. J. B.	Ston Easton Park, Bath	1	0	0
Hiscock, A.	Motcombe, Dorset	1	0	0
†Hoare, Sir H. H. A., Bart.	Stourhead, Zeals, S.O., Wilts.	..		
Hoare, H. C.	Stourhead, Bruton	1	0	0
*Hobhouse, Rt. Hon. H.	Hadspen House, Castle Cary.	2	0	0
†Hoddinott, S.	Worminster, Shepton Mallet	..		
Holland and Coombs	Bristol	1	0	0
Holt Needham, O. N.	Barton Court, Colwall, near Malvern	1	0	0
†Hope, W. H. B.	Eastwood, East Harptree, Bristol	..		
Hopper, H. R.	Merryweather & Sons, Greenwich Road, London, S.E.10	1	1	0

Name.	Residence.	Subscriptions. £	s.	d.
†Horner, Sir J. F. Fortescue	Mells Park, Frome . . .	..		
Hornsby and Sons (Ltd.) .	Grantham, Lincoln . . .	1	0	0
Horton, Rev. Preb. Le G. .	Wellow Vicarage, Bath . .	1	1	0
Hosegood, A. W. . .	Williton, Taunton . . .	1	0	0
Hosegood, Obed., jun. .	Dillington, Ilminster . . .	0	10	0
†Hoskins, R. J. . . .	Beard Hill, Shepton Mallet . .	..		
Hoskyns, H. W. P. . .	North Perrott Manor, Crewkerne, Somerset	1	0	0
Houldsworth, A. F. . .	Widcombe, Kingsbridge, Devon .	1	1	0
Hudson, E. V. . . .	Wolseley Works, Witton, Birmingham	1	0	0
†Hughes, A. E. . . .	Wintercott, Leominster . .	..		
Humphries, Sidney . .	Eastfield Lodge, Westbury-on-Trym, Bristol	1	1	0
Hunter, Sir Charles, Bart., M.P.	1, West Eaton Place, London, S.W.1	1	0	0
†Hurle J. C. . . .	Brislington Hill, Bristol . .	..		
Hurst and Son . . .	152, Houndsditch, London, E.1 .	1	0	0
Hussey, J. W. . . .	Bouverie House, Exeter . .	1	0	0
†Hylton, Lord . . .	Charlton, near Radstock . .	..		
Ibbotson, R. . . .	The Hawthorns, Knowle, Warwickshire	1	0	0
*Ilchester, Earl of . .	Melbury, Dorchester . . .	2	2	0
Imperial Live Stock Insurance Co. . . .	17, Pall Mall, East, London, S.W..	1	0	0
International Harvester Co. (Ltd.) . . .	80, Finsbury Pavement, London, E.C.	1	0	0
Ireland, A. C. . . .	Brislington Hill, near Bristol .	1	1	0
Irvine, H. O. . . .	Southerndon, Bridgend, Glam. .	1	0	0
*Islington, Lord . .	Hartham Park, Corsham . .	2	0	0
*Ismay, J. H. . . .	Iwerne Minster, Blandford, Dorset	2	0	0
Jackman, Percy . .	Pulteney Hotel, Bath . .	1	0	0
Jackson, Sir H. M., Bart. .	Llantillio Court, Abergavenny .	1	0	0
James, S. . . .	Ham Farm, Shepton Mallet . .	1	0	0
Jardine, E., M.P. . .	The Park, Nottingham. . .	1	1	0
Jarmain, T. M. . . .	Haseley Iron Works, Tetsworth .	1	1	0
Jenkins, D. . . .	Flemingston Court, Cowbridge, Glam.	1	0	0
Jenkins, E. . . .	c/o F. Capern, Lewin's Mead, Bristol	1	0	0
Jenkins, Captain Vaughan .	St. Winifreds, Combe Down, Bath	1	0	0
*Jersey, Earl of . .	Middleton Park, Bicester, Oxon .	2	0	0

Name.	Residence.	Subscriptions. £	s.	d.
†Jervoise, Mrs. B. A. L.	Herriard Park, Basingstoke	..		
Jervoise, F. H. T.	Herriard Park, Basingstoke	1	1	0
Jeyes' Sanitary Compounds Company	Cannon Street, London, E.C.4	1	0	0
John, E.	Cowbridge, Glamorgan	1	0	0
Jones, T. S.	Frondez, Radyr, Cardiff	1	0	0
Keeling, G.	North Hill Farm, Dunkerton, Bath	1	0	0
Kekewich, T. H., J.P.	Peamore, Exeter	1	0	0
Kell & Co.	Gloucester	1	0	0
Kelly, Col. A. L.	Cadbury House, Wincanton, Somerset	1	0	0
Kelway, W	Huish Episcopi, Langport	1	1	0
†Kemp, L. J.	Maer, Exmouth	..		
Kennaway, Rt. Hon. Sir J. H., Bart., M.P.	Escot, Ottery St. Mary	1	1	0
Kennaway, J.	Escot, Ottery St. Mary	1	0	0
*Keyser, C. E.	Aldermaston Court, Reading	2	0	0
King, J., M.P.	Sandhouse, Witley, Surrey	1	0	0
King and Sons, R.	Milsom Street, Bath	1	1	0
King, W. E. M.	Donhead Lodge, Salisbury	1	0	0
Kingwell, H. J.	Great Aish, South Brent, S. Devon	1	0	0
Knight, S. J.	Walnut Farm, East Dundry, near Bristol	1	0	0
†Knollys, C. R.	Weekley, Kettering	..		
Knox, E.	Kilmersdon, Bath	1	1	0
†Kruse, W.	Perran Bay House, Perranporth, Cornwall	..		
†Lake, C.	Oakley, Higham, Kent	..		
Lane, A. P.	Arthur's Club, St. James's, London	1	0	0
*Lansdowne, Marquis of	Bowood, Calne	2	0	0
Larkworthy, E. W.	Messrs. J. L. Larkworthy & Co., Worcester	1	0	0
†Latham, T.	Dorchester, Oxon	..		
Lawes, Algernon (Ltd.)	203, Hornsey Road, London, N.7	1	1	0
Lear, H. H.	His Grace the Duke of Marlborough's Farm, Bladon, Woodstock, Oxon.	1	0	0
Lee, Major-Gen. H. H.	The Mount, Dinas Powis, Cardiff	1	0	0
Leeder, E. H.	Mount Pleasant House, Swansea	1	0	0
Legard, A. G.	Brow Hill, Batheaston, Bath	1	0	0
Lennard, Sir H., Bart.	Wickham Court, West Wickham, Kent	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Lethbridge, Charles	Carlton Club, London, S.W.	1	0	0
Leverton, W. A.	Columb John Farm, Stoke Canon, Exeter	1	0	0
Leverton, W.	Woolleigh Barton, Beaford, North Devon	0	10	0
Lewis, Col. H.	Green Meadow, near Cardiff	1	1	0
Lewis, Wm. and Son (Ltd.)	*Herald* Office, Bath	1	0	0
†Ley, John Henry	Trehill, Exeter		..	
†Leyland, C. J.	Haggerston Castle, Beal, Northumberland		..	
Liddell, C. O.	Shire Newton Hall, Chepstow	1	1	0
Liddon, E., M.D.	Silver Street House, Taunton	1	0	0
Linton, E. N.	Westgate Chambers, Newport, Mon.	1	0	0
Lipscomb, Godfrey	Margam Park, Port Talbot	1	0	0
Lister, R. A. & Co. (Ltd.)	Dursley, Glos.	1	1	0
†Lister, J. J.	Warninglid Grange, Haywards Heath		..	
Llewellyn, Lieut.-Col. A.	Writtenhall, Bewdley, Worcestershire	1	0	0
Llewellyn Llewellyn, T. E.	Hackwood, Basingstoke	1	0	0
*Llewelyn, Sir J. T. D., Bart.	Penllergaer, Swansea	2	2	0
Lloyd, J. C.	Dinas, Brecon	1	0	0
*†Long, Rt. Hon. Walter H., M.P.	Rood Ashton, Trowbridge		..	
Long, Col. William	Woodlands, Congresbury, Somerset	1	0	0
Long, W. F.	New Barnes Farm, Bromyard	1	0	0
Longrigg, G. E.	Weston Lea, Bath	1	0	0
Lopes, Sir H. Y. Buller, Bart.	Maristow, Roborough, Devon	1	0	0
Loram, Brothers	Cathedral Dairy, Exeter	1	1	0
Lovelace, T.	Bratton Court, Minehead, Somerset	1	0	0
Lubbock, Major G.	Greenhill, Warminster, Wilts	1	0	0
†Lutley, J. H.	Brockampton, Worcester		..	
Luttrell, Capt. A. F.	Court House, East Quantoxhead, Bridgwater	1	0	0
Luttrell, Claude M. F.	15, Gay Street, Bath	1	1	0
McCalmont, Major D. H. B.	Crockford's Hall, Newmarket	1	1	0
Macdonald, H. L. S.	Avondale, Bathford, Bath	1	0	0
McIntosh, Mrs. C. M.	Havering Park, Havering Atte Bower, Essex	1	1	0
Major, H. J. and C. (Ltd.)	Bridgwater	1	0	0
†Mansell, A. E.	Mount Vernon, Melton Mowbray, Tasmania		..	
Marcus, M.	High Trees, Redhill, Surrey	1	0	0
Marfell, R. H.	Great House Farm, Llangeview, Usk	1	0	0

Name.	Residence.	£	s.	d.
Marshall, L. H.	Chippenham	1	0	0
Marshall, Sons & Co. (Ltd.)	Britannia Iron Works, Gainsborough	1	0	0
Martin, E. G. Bromley	Ham Court, Upton-on-Severn	1	0	0
Martin, J.	Thorverton, R.S.O., Devon	1	0	0
Martin, L. J. (Associated Manufacturers' Assn.)	72-80, Mansell Street, Aldgate, London, E.1	1	0	0
Martin and Carnes	Taunton	1	1	0
Martyn, G.	Tremeddan, Liskeard, Cornwall	1	1	0
Mason, F. F.	Swansea	1	0	0
Massey-Harris Co. (Ltd.), (C. W. Dawkins, General Manager)	54 & 55, Bunhill Row, London, E.C.1	1	0	0
Masters, A.	29, St. Mary Street, Cardiff	1	0	0
Mathews, Ernest	Little Shardeloes, Amersham, Bucks	1	0	0
Mathews, E. R. Norris, F.R.Hist. Soc.	Central Library, Bristol	1	0	0
Matthews, Adam	The Cornhill Stud, Swansea	1	0	0
Maule, Major-Gen. H. B.	2, Penn Lea Road, Newbridge Hill, Bath	1	0	0
Maule, M. St. John	Chapel House, Bath	1	0	0
May, A. C.	Avon House, Stoke Bishop, Bristol	1	0	0
Meade-King, W. O.	Walford House, Taunton	1	0	0
Meager, F. F.	Melbourne House, Swansea	1	0	0
Meddick, William G.	11, Great Stanhope Street, Bath	1	0	0
Membery, R.	37, Southgate Street, Bath	1	0	0
Merry, Richard	Goulds, Broadclyst, Exeter	0	10	0
Methuen, General Lord; C.B., C.M.G.	Corsham Court, Wilts	1	0	0
Mildmay, Capt. C. B. St. J.	Hallam, Dulverton	1	0	0
†Mildred, G. B.	. . . .		..	
Millbank, Sir Powlett C. J., Bart.	Norton Manor, Presteign	1	0	0
Miller, T. H.	St. Albans, Weston Park, Bath	1	0	0
Miller-Hallett, A.	Goddington, Chelsfield, Kent	1	1	0
Mills, B. W.	31, Cambridge Place, Paddington, London, W.	1	0	0
Mitchell, Mrs. C. L.	Highgrove, Tetbury	1	0	0
Molassine Co. (Ltd.)	East Greenwich, London, S.E.	1	0	0
Moody, C.	Maisemoor, Evercreech	1	0	0
Moore-Gwyn, J. E.	Duffryn, Neath, Glamorgan	1	0	0
†Moore, H. F.	Renée House, 48, Dulwich Road, Herne Hill, S.E.24		..	
Moore, Sir Newton J., K.C.M.G.	Savoy House, Strand, London, W.C.2	1	1	0
Moore-Stevens, Col. R. A.	Winscott, Torrington, Devon	1	0	0

Name.	Residence.	£	s.	d.
Morant, Mrs. E.	Brokenhurst Park, Hants	1	0	0
Morel, C. E.	. . . .	1	0	0
*Moreton, Lord	Sarsden Lodge, Chipping Norton	2	2	0
Morgan, W. A.	Winthankley, St. Andrew's, Fife	1	1	0
*Morley, Earl of	Saltram, Plympton, Devon	2	0	0
*Morris, C.	Highfield Hall, St. Albans	2	0	0
Morris and Griffin (Ltd.)	Maindee, Newport, Mon.	1	1	0
Morris, Sir R. A., Bart.	Sketty Park, Swansea	1	0	0
Morris, Son and Peard	Auctioneers, North Curry, Taunton	1	0	0
Morrison, Col. J. A.	Berwick House, Hindon, Salisbury	1	0	0
†Morrison, J. A.	Basildon Park, Reading		..	
Mount-Edgcumbe, Earl of	Mount Edgcumbe, Devonport	1	1	0
†Mucklow, E., J.P.	Woodhill, Bury, Lancashire		..	
Munn, F.	Dumballs Road, Cardiff	1	0	0
Muntz, F. E.	Umberslade, Hockley Heath, Warwickshire	1	0	0
Muntz, Capt. J. O.	Foxhams, Horrabridge, S. Devon	1	0	0
Murray-Anderdon, H. Edwd.	Henlade House, Taunton	1	1	0
Napier, H. B.	Ashton Court Estate Office, Long Ashton, Bristol	1	1	0
Neal, J. F.	Kingsdon, Taunton	1	0	0
Neeld, Sir A. D., Bart., C.B.	Grittleton, Chippenham	1	0	0
Nelder, C. W.	Carnarvon Arms, Dulverton, Somerset	0	10	0
†Neville Grenville, Robert	Butleigh Court, Glastonbury		..	
New, H. G.	Craddock, Cullompton, Devon	1	0	0
Newington, C.	Oakover, Ticehurst, Sussex	1	0	0
Newman, Sir R. H. S. D. L., Bart.	Mamhead Park, near Exeter	1	1	0
Nicholetts, E. C.	The Lons, Bitton, Gloucestershire	1	0	0
Nichols, G.	49, Broad Street, Bristol	1	0	0
Nitrogen Fertilisers (Ltd.)	Winchester House, Old Bond Street, London, E.C.2	1	0	0
Nix, J.	Tilgate, Crawley, Sussex	1	1	0
Nixon, W.	The University, Bristol	1	0	0
*Normanton, Earl of	Somerley, Ringwood	2	0	0
North, G. F.	Stratfield Saye, Mortimer, R.S.O., Berks.	1	0	0
*Northumberland, Duke of	Albury Park, Guildford	5	0	0
Oakey, G.	Brittleware Farm, Charlwood, Surrey	1	0	0
Oakley, H. E.	Dewstow, near Chepstow	1	0	0

Name.	Residence.	Subscriptions. £ s. d.
†O'Hagan, Lord	Pyrgo Park, Havering Atte Bower, Romford, Essex	..
O'Halloran, Miss P.	Fairwood Lodge, Killay, R.S.O., Glam.	1 0 0
Olver, J. C.	Woodland Valley, Ladock, Cornwall	1 0 0
Osborne, J.	9, Clifton Park, Clifton	1 1 0
Osmond and Son	Grimsby	1 0 0
Paget, A. B.	Bathwick Estate Office, 100, Sydney Place, Bath.	1 0 0
Paget, L. C.	Middlethorpe Hall, Yorks	1 0 0
*Paget, Sir Richard, Bart.	9, King's Bench Walk, Temple, London	2 0 0
Palmer, G. Ll.	Lackham, Lacock, Wilts	1 0 0
†Palmer, R.	Lodge Farm, Nazeing, Waltham Cross, Essex	..
Palmer, W. H.	York Buildings, Bridgwater	1 0 0
†Parker, Hon. Cecil T.	The Grove, Corsham, Wilts	..
Parker, F. J.	Plymouth Street, Swansea	1 0 0
Parmiter, P. J. & Sons	Tisbury, Wilts	1 0 0
Parry-Okeden, Lieut.-Col. U. E. P.	Turnworth, Blandford	1 0 0
†Parsons, J. D. Toogood, jun.	Manor View, Rusthall, Tunbridge Wells	..
†Parsons, R. M. P.	Misterton, Crewkerne	..
Pass, A. D.	Manor House, Wootton Fitzpaine, Charmouth, Dorset	1 0 0
Peacock, W.	3, Buckingham Gate, London	1 1 0
Pearce, S. & Co.	46a, Market Street, Manchester	1 0 0
Pearse, T. C.	Leigh Farm, Dulverton	1 0 0
Peel, Viscount	52, Grosvenor Street, London, W.	1 1 0
Pember, G. H.	. . . .	1 0 0
Penberthy, Professor J.	Dean Hall, Newnham, Glos.	1 0 0
Pendarves, W. Cole	Pendarves, Camborne, Cornwall	1 1 0
Pennefather, de F.	Kinnersley Castle, Hereford	1 0 0
Perkins, Col. E. K.	Shales, Bitterne, Hants	1 1 0
Petherick, R., jun.	Acland Barton, Landkey, Barnstaple	0 10 0
Petters (Ltd.)	Yeovil	1 0 0
Pettifer, T. & Co.	Eydon, Banbury	1 0 0
Phillips, F.	Nantcoch, Newport, Mon.	1 1 0
Phillips, G.	The Gaer, Newport, Mon.	1 0 0
Phillips, J. F. Lort	. . . .	1 0 0
Phillips, L. R.	. . . .	1 1 0
Piggott, Brothers & Co.	220, 222, 224, Bishopsgate Street, Without, London, E. C.	1 0 0

Name.	Residence.	£	s.	d.
Pike, C. A.	Chilean Nitrate Committee, Friar's House, 39-41, New Broad Street, London, E.C.2.	1	0	0
†Pinney, R. W. P.	Sutton Veny, Warminster		..	
†Pitt, W.	South Stoke House, Bath		..	
Plaister, C.	Church Farm, Monkton Combe, Bath	1	0	0
Plumptre, H. F.	Goodnestone, Dover	1	0	0
*Plymouth, Earl of	Hewell Grange, Bromsgrove	4	0	0
*Poltimore, Lord	Poltimore Park, Exeter	3	3	0
Poole, Mrs. A. R.	King's Hill, Dursley	1	1	0
Pope, Alfred	Dorchester	1	0	0
Pope, John	Nowers, Wellington, Somerset	1	0	0
Pope, S. P.	Howden, Tiverton, N. Devon	1	1	0
Popham, H. L.	Hunstrete House, Pensford, Bristol	1	0	0
Porter, W. J. H.	Glendale Farm, Wedmore	1	0	0
†Portman, Hon. C. B.	Goldicote, Stratford-on-Avon		..	
Portman, Hon. Mrs. C. B.	Goldicote, Stratford-on-Avon	1	0	0
*Portman, Viscount	Bryanston, Blandford	5	0	0
Price, Owen	Nantyrharn, Cray, Brecon	1	0	0
Prichard, H. L.	Penmaen, R.S.O., Glam.	1	0	0
Pritchard, D. F., J.P.	Crumlin Hall, Crumlin, Mon.	1	1	0
Proctor, H. and T. (Ltd.)	Cathay, Bristol	1	1	0
Pullen, James	Lapdown Farm, Tormarton, Gloucester	1	0	0
†Purgold, A. D.	Ebna Lodge, Gobowen, Salop		..	
Quantock Vale Cider Co.	North Petherton, Bridgwater	1	0	0
Quested, J. E.	The Firs, Cheriton, Kent	1	0	0
*†Radnor, Earl of	Longford Castle, Salisbury		..	
†Ransome, B. C.	Orwell Works, Ipswich		..	
Rawlence, Ernest A.	Newlands, Salisbury	1	0	0
Rawlence, Capt. G. Norman	Salisbury	1	0	0
Read, B.	Church Farm, Cam, Dursley, Gloucester	1	0	0
Rees, W. J.	The Laurels, Swansea	1	1	0
Reeves, Robert and John, and Son	Bratton Iron Works, Westbury, Wilts	1	0	0
Remnant J. F., M.P.	The Grange, Hare Hatch, Twyford	1	0	0
Rhondda, Lord	Llanwern, Newport, Mon.	1	1	0
Rice, Rees	Velindre, Morriston, Glam.	0	10	0
Richardson, Rev. A.	Bath and County Club, Bath	1	0	0
Riley, J. L. & A.	The Iwerne, near Ledbury	1	0	0
Robins, J.	High Bray, South Molton	0	10	0

Name.	Residence.	Subscriptions. £	s.	d.
Robins, W. &. H. V.	Gratton Barton, High Bray, South Molton	1	0	0
Robinson, E. S. & A. (Ltd.)	Redcliffe Street, Bristol	1	1	0
Robinson, John & Co.	Bristol	1	1	0
Roe, W. J.	West Pennard, Glastonbury	1	0	0
Rogers, E. P.	Burncoose, Perranwell, Cornwall	1	0	0
Rogerson R. W.	Ward & Co., Seedsmen, Bath	1	0	0
Rolleston, S. V.	Saltford House, Saltford, Bristol	1	0	0
Rolleston, Col. V., J. P.	Saltford House, near Bristol	1	1	0
Roundway, Lord	Roundway Park, Devizes	1	0	0
Rouse-Boughton, Sir W. St. A., Bart.	Downton Hall, Ludlow	1	0	0
Rouse-Boughton, Lady	Downton Hall, Ludlow	1	0	0
Rowlands, P. S.	The Laurels, Stangennith, Reynoldston, S.O., Glam.	1	1	0
Rowliffe, E. L.	Hall Place, Cranleigh, Guildford	1	1	0
Royal Guernsey Agricultural and Horticultural Society	Guernsey	1	0	0
Ruston, Proctor & Co. (Ltd.)	Lincoln	1	0	0
Rutherford, J. A.	Highclere Estate Office, Newbury, Berks	1	0	0
Saillard, P.	Buchan Hill, Crawley, Sussex	1	0	0
*St. Germans, Earl of	St. Germans, Cornwall	2	0	0
†Salmon, H. C.	North Field, Bridgwater		..	
Salter, Benjamin	Newlands, Broadclyst, Exeter	1	0	0
Salter, T.	Beare Farm, Broadclyst, Exeter	1	0	0
Samuel, A.	74, Mansel Terrace, Swansea	1	0	0
Samuelson, Ernest	Bodicote Grange, Banbury	1	1	0
Sanders, Col., R. A., M.P.	Barwick House, Yeovil	1	0	0
Sandys, Capt. G. J., M.P.	Hatherleigh House, Weston-super-Mare	1	1	0
Sanford, Col. E. C. A., C.M.G.	Nynehead Court, Wellington, Somt.	1	0	0
Sanford, H. S. J. A.	The Court House, Middlehill, Broadway, Worcestershire	1	0	0
Sankey, R. I.	Queen Anne Mansions, St. James's Park, London, S.W.	1	0	0
†Scott, T.	. . . .		..	
†Seaton, Lord	Beechwood, Plympton, Devon		..	
Sedgwick, T. E.	26, Oriental Street, Poplar, London, E.	1	1	0
Senior and Godwin	Auctioneers, Sturminster Newton, Dorset	1	1	0
†Shaw-Stewart, Walter R.	Hayes, Shaftesbury		..	
*Shelley, Sir John, Bart.	Shobrooke Park, Crediton	2	2	0
Shelley, Capt. J. F.	Posbury House, near Crediton	1	0	0

Name.	Residence.	£	s.	d.
Sheppard, P. C. O. . .	Dunraven Estate Office, Bridgend, Glam.	1	1	0
†Sherston, C. J. T. . .	Harewood, Leeds . . .	..		
*Sidmouth, Viscount . .	Upottery Manor, Honiton . .	2	0	0
Sillifant, A. O. . . .	Culm Leigh, Stoke Canon, Exeter .	1	0	0
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(32)		
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BREEDERS'. DIRECTORY.

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SHEEP—*continued.*

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PIGS—*continued.*

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PIGS—*continued.*

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